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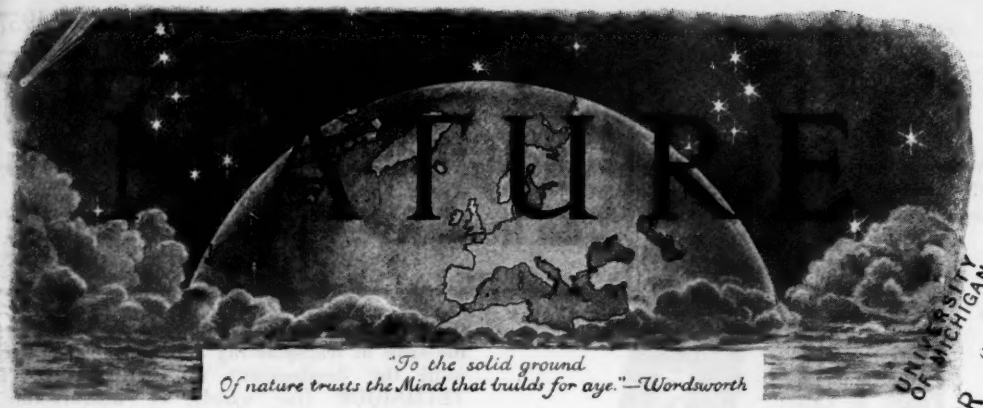

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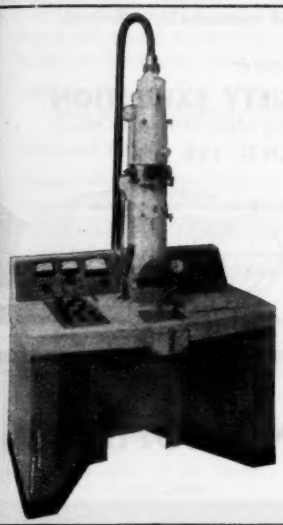

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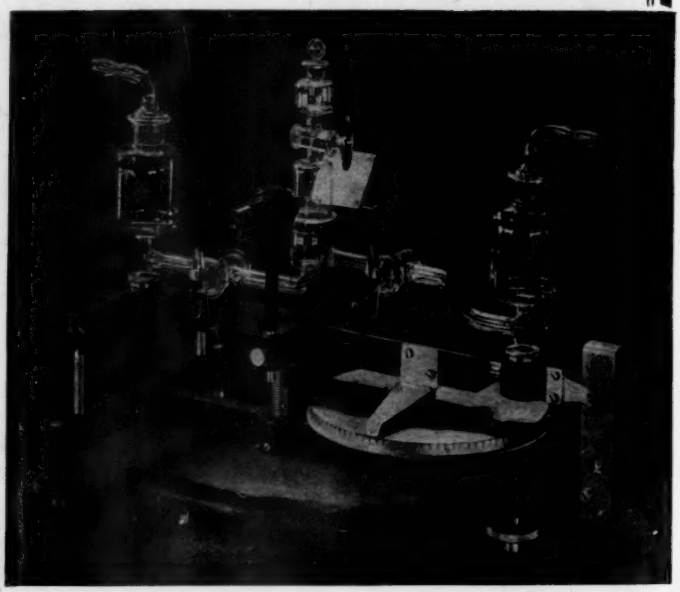

NATURE

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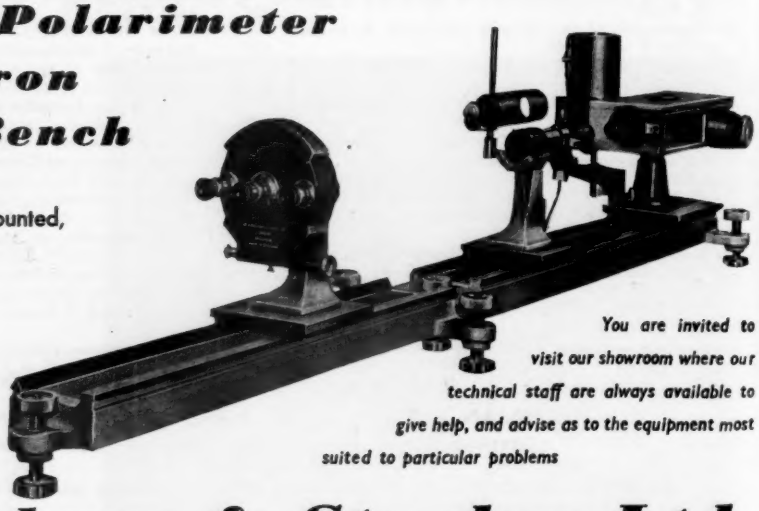

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THE TRAINING OF ENGINEERS

IN common usage the words education and training are not sharply differentiated in their meanings. There are, however, instances in which it is useful to assign to each a special significance. An example of this is to be found in a report issued recently by the Institution of Electrical Engineers under the title "The Training of Graduates"*. As with the medical doctor and the lawyer, the qualification of the professional engineer involves both academic study and experience of practice, and to these divisions of his preparation are assigned the two terms. "Training," states the report, "is the term used for the portion of the course concerned with the acquisition of experience of engineering practice and of the techniques appropriate to a professional engineer."

While it is true that engineering graduates in Britain have received training in industry throughout the whole period of nearly one hundred and twenty years since the inception of the engineering schools in British universities, it is only within the past fifty years that a generally recognized pattern of training has evolved.

Civil engineering in the full scope of its original conception comprised the whole field of technology outside the area of strictly military application. The often quoted words of the Royal Charter of the Institution of Civil Engineers, "the art of directing the great sources of power in Nature for the use and convenience of man", establish a clear title to universality. In the event, however, engineering has developed sub-divisions, and civil engineering, in an accepted restricted sense, is only one of three, sharing with mechanical and electrical engineering the coverage of the main field of engineering practice. These major divisions of the field comprise many areas of specialization, some long established, such as marine engineering and mining engineering, while others like aeronautics, electronics and chemical engineering are relatively new. Graduate training, although it has the same basic meaning in all branches, has a somewhat different detailed interpretation for each of them. Civil engineering and mechanical engineering began as crafts and had achieved considerable development before the unifying scientific principles underlying them had been enunciated and had, by their incorporation, created two major branches of applied science. Electrical engineering, on the other hand, had no craft ancestry, except in the mariner's compass, and came to birth as the child of pure science.

It is not difficult to understand how the individual master and pupil relationship of medieval apprenticeship became the normal method of entry to engineering as a craft and so continued while the scientific framework was being slowly built into the craft fabric. The practice of deliberate association of a university education with a career in engineering developed very slowly during the nineteenth century, and the engineering graduates, few in number, had for the most part to struggle on entering industry against ignorance and prejudice. At Cambridge the Mechanical Sciences Tripos was not established until 1892, under Ewing. Prior to that, many prospective engineers read mathematics. It is interesting to note that Parsons, who was eleventh wrangler in 1877, attended such lectures on mechanism and applied mechanics as were given in the University and that, following graduation, he served a *four*-year apprenticeship at the Elswick Works of Sir William Armstrong and Company. Not until the turn of the present century was it recognized as desirable to provide in industry special schemes of apprenticeship for university graduates.

Civil engineering retains in the highest degree the practice of pupilage with a master in which the pupil, whether or not he is a university graduate, acquires by day-to-day association with senior men in the practice of the profession the knowledge and experience which will in due course establish his professional competence. The Institution of Civil Engineers lays down that the university graduate shall, in addition to certain other requirements, have had at least two years training as an articled pupil, apprentice or assistant under agreement with a chartered civil engineer.

Pupilage, in the directly personal sense in which it can be practised in civil engineering, is much less practicable in mechanical or electrical engineering, for the master or his deputy is more rarely a clearly identifiable individual and indeed is often a very highly complex entity. This results largely from the fact that practice in an independent consultative capacity, although an important activity in relation to mechanical and electrical engineering, is proportionately much less so than in civil engineering, and a high proportion of mechanical and electrical engineers are employed in manufacturing or operating organizations or in research establishments.

Traditionally in these two branches of engineering the graduate apprentice spends some time 'at the bench' learning something of the basic operations and of the men who carry them out, and generally forming a first-hand acquaintance with the techniques of engineering manufacture. While it is not expected that the graduate will achieve any considerable degree of manual skill, he should have sufficient first-hand experience to enable him to understand the fundamental problems of manufacture and to appreciate the outlook of engineering craftsmen. The assembly, inspection and especially the testing of machinery and equipment constitute an important part of the course of training. Finally, the young graduate will be introduced to the branch of work in which he will take up his first professional responsibilities, for example, in design, in research or in manufacture. It is not difficult to understand that training of this kind, if it is conducted in a relatively large manufacturing organization, will involve the co-operation of many

* The Professional Electrical Engineer: The Training of Graduates. (A Report of the Joint Committee on Practical Training in the Electrical Engineering Industry.) Pp. 35. (London: Institution of Electrical Engineers, 1957.) 2s.

individuals in positions of widely varied character and responsibility, and will require a carefully devised and executed scheme of organization. Equally, it may not be practicable to provide a wholly satisfactory scheme of training in a firm of relatively small size.

The report to which reference has already been made deals with the organization of schemes of training for graduate electrical engineers. The main recommendations of the report may be summarized as follows.

The training programme should last two years and should comprise three parts, namely, basic workshop training, general mechanical and electrical training and directed objective training. No specific recommendations are made in regard to the periods to be allocated to the three parts, but it is suggested that an appropriate division might be three to four months on basic workshop training, eight to fifteen months on general mechanical and electrical training and six to twelve months on what is termed directed objective training. By this is meant training which is more closely related to the specific type of work which the graduate intends to take up on the completion of his training period.

Following these rather general considerations, the report goes on to outline the character of the training in the three main divisions but does so under two heads: first, that of training in a works making heavy electrical plant and equipment; and secondly, training in a factory making light electrical equipment. It is noteworthy that attention is directed to the possibility that, in a firm manufacturing a rather limited range of products, the training might be too narrow and it might be advisable for the trainee to be sent to other organizations for a period for the purpose of gaining wider experience. Equally noteworthy is the provision of special programmes of training for graduates in operating organizations and in research establishments.

The comment is made in the sections dealing with basic workshop training that this can be made more effective by its association with classroom instruction and that, in some firms, training schools cover a substantial part of this work. The view is expressed, however, that work in a training school should always be supplemented by experience in production departments where the trainee may mix with craftsmen and technicians on 'the shop floor'. Emphasis is placed on the provision of suitable test experience as part of the general mechanical and electrical training phase of the course, as this gives an excellent opportunity for the acquisition of knowledge as to how items of equipment are constructed and operated and of the standard by which their performance will be assessed. A further feature of training should be the requirement to study the practical, technical and managerial considerations relating to the project in hand and to present in a written report the trainee's conclusions and recommendations.

Directed objective training represents the final phase of the training programme, and this, as has been mentioned, relates fairly closely to the trainee's chosen field of work. Seven main sub-divisions are given as follows: (*a*) research; (*b*) development; (*c*) design and application; (*d*) manufacture; (*e*) outside erection and installation; (*f*) operation and maintenance; and (*g*) commercial engineering.

It is assumed that, by the end of the general training period, the trainee will have decided, aided by the advice of management, the branch of work in which he will commence his professional career. Thus, during the final period his programme should be determined in co-operation with the head of the department in which he hopes to take up an appointment.

There are several references to the desirability of the trainee continuing his studies during the training period, and it is pointed out that suitable short special courses are often available at local technical colleges. It may occasionally be appropriate for the trainee to spend up to a year on full-time postgraduate study in a university or in a college of technology, provided such studies are directly related to the work which he will be taking up.

An interesting feature common to both the 'heavy current' and 'light current' programmes is the suggestion that the trainee in the manufacturing organization might well have some experience with an appropriate *operating* authority, in one case an organization using heavy electrical plant such as the Central Electricity Authority, or in the other, for example, the Post Office or the British Broadcasting Corporation.

For graduates in operating organizations the recommendations for basic workshop training are similar to those for the manufacturing side, but there is an important difference under general mechanical and electrical training. Here it is stated that this phase of training can only be implemented fully with the co-operation of *manufacturing* firms in which experience can be gained of fitting, assembly work, inspection and testing. The directed objective training, which it is recommended should occupy from six to twelve months, is subdivided under four heads: (*a*) operation and maintenance; (*b*) installation; (*c*) commercial engineering; and (*d*) research and design.

A separate section of the report is devoted to training in research establishments, in particular, the research laboratories of government departments or of research associations. The proposed scheme could, it is suggested, apply not only to graduates in engineering but also to graduates in physics and mathematics who wish to qualify professionally as electrical engineers.

The basic workshop training for this group occupies two months. This should be followed by four to six months in laboratories, of general electrical and mechanical training, which should comprise work on the commonly used structural, conducting, magnetic and insulating materials, and in addition should provide some experience of the main branches of physical measurement. Thereafter, six to nine months of general mechanical and electrical training should be obtained outside the laboratories, and finally the directed objective training, occupying six to twelve months, should constitute an introduction

to research methods obtained by engagement on selected research projects. This should carry individual responsibility under the direct supervision of a senior research engineer.

The report concludes with a group of sub-sections offering suggestions as to the structure of apprentice associations, hostel accommodation and the provision of library and study facilities. An appendix gives in tabular form a summary of typical programmes for graduates in a variety of branches of the electrical industry.

There is no revolutionary change in practice in the recommendations of this report. On the other hand, it does provide for balanced schemes of training for sections of the industry in which in the past there was little such provision. It is important to recognize that the British system of education and training differs quite materially from the corresponding systems for professional engineers in the United States, Western Europe and the U.S.S.R. The graduate apprenticeship as it is understood in Britain is not a feature of American industry. On the continent of Europe the five and a half year course of the technical college comprises some of the material which the British graduate acquires during his practical training. All these systems are no doubt open to criticism on one ground or another, but equally they all work comparatively well. It is probably wise in Britain to accept the proverbial virtue in diversity and to endeavour to mould something which has a long native tradition to meet modern requirements. At the same time, when British industry has to meet intense competition in world markets and is experiencing a severe shortage of scientific man-power, it is of supreme importance that the practical training of engineering graduates should be soundly conceived and efficiently executed. The report on the training of graduates which has been produced by the Institution of Electrical Engineers is a most welcome aid to national self-criticism in this important matter. It is, however, not unjustified to ask whether, in the engineering industry as a whole, the profound character of the changes which are taking place have been fully recognized in relation to their effects on training. Nuclear energy, the application of semiconductors and the use of high-speed electronic computers indicate some of the ways in which fundamental science will increasingly influence engineering practice. Is not this factor one which should affect most strongly the development of engineering training in the immediate future ?

THE LIFE AND WORKS OF ARCHIMEDES

Archimedes

By E. J. Dijksterhuis. (Acta Historica Scientiarum Naturalium et Medicinalium, Vol. 12.) Pp. 422. (Copenhagen : Ejnar Munksgaard, 1956.) 68 kronor.

IT is curious how few facts of real importance are known about the life and parentage of Archimedes, while the trivial story of his leaping out of his bath shouting "Heureka" is familiar to every schoolboy. The first record of it, however, is in the works of Vitruvius, written about two hundred years after Archimedes's death, so that there was ample time for the story to have been embroidered, even if it is not a pure invention. It is much the same with the account of his launching a large ship single-handed, saying, "Give me a place to stand on and I will move the earth", and with the myth that he burned the Roman fleet by using mirrors on a sunny day.

These traditional stories, and others, are critically considered in Prof. E. J. Dijksterhuis's book and traced to their original sources ; but this constitutes little more than one-twentieth of his book. The rest is a translation of all the known works of Archimedes, preceded by a short account of the origin and history of the various texts and codices. It makes clear what a tremendous contribution Archimedes made to geometry, astronomy, mensuration, statics and hydrostatics, and how very near he came to a formulation of the integral calculus. The method by which he determined the ratio of the circumference of the circle to its diameter by calculating the perimeter of the circumscribed polygon of 96 sides to arrive at his approximate value of 22/7 can be followed with interest.

Comparison of this new translation with that which Sir Thomas Heath made sixty years ago is inevitable. Prof. Dijksterhuis smooths the way of the reader by including a long preliminary chapter called "The Elements of the Work of Archimedes", in which he collects the basic ideas and elementary propositions which will be applied in the subsequent works. This allows him later to omit some of those introductory and subsidiary propositions which might obscure the main line of Archimedes's argument. In some cases, too, he omits propositions which are redundant because Archimedes proves both the general, as well as a particular, case. At the same time, he continuously adds his own comments where necessary and explains Archimedes's line of attack, whereas Heath produced a more literal and complete translation of the original Greek, confining his explanations mainly to his introductory chapters and making little comment in the translated text.

In his book on the growth and establishment of the mechanical explanation of physical phenomena (called "Die Mechanisierung des Weltbildes"), Dijksterhuis showed his understanding of the processes of thought of early philosophers, and his comments in this translation do much to shed light on those of Archimedes.

The work under review first appeared in Dutch between 1938 and 1944, and Miss C. Dikshoorn has here translated it into English. The English is almost, but not quite, perfect. A further small criticism is that the English reader would, I think, prefer Roman to Greek lettering on the geometrical diagrams, and he will not find the notation generally quite so familiar as that used by Heath. As references in the text are given to earlier chapters and sections rather than pages, it would have been a convenience if the number of the chapter had been printed at the top of each page.

Prof. Dijksterhuis's book will appeal to those with a general knowledge of mathematics who are interested to learn about the methods and achievements of Archimedes, and because Heath's book is long since out of print this new version of the works is to be welcomed.

H. R. CALVERT

AFRICAN GRASSHOPPERS

Annotated Catalogue of African Grasshoppers

By H. B. Johnston. Pp. xxii + 833. (Cambridge: At the University Press, 1956. Published for the Anti-Locust Research Centre.) 105s. net.

THE appearance of this catalogue heralds the approach of a new era in the study of African grasshoppers. Until a score or so of years ago, our knowledge of the grasshopper fauna of this continent was too rudimentary for a list of species to have more than an ephemeral value, and it is only during the past decade that descriptive and revisionary work on the family has reached a level which permits, as it were, a pause for breath.

After prefatory remarks on the need for a catalogue, the text proper opens with an introduction explaining the scope and general layout of the work. In addition to the Acrididae, two other Acridoid families are incorporated in the catalogue: the Pneumoridae and Eumastacidae. The whole of the African continent is covered, including the adjacent islands to the east and west but not those of the Mediterranean Sea. The catalogue aims to index, by means of references under species and a terminal bibliography under authors, all the information published on the grasshoppers of this area up to the end of 1953. No reference is made to the fact that a certain amount of information published in 1954 is included both in the text and bibliography, but one assumes that this year is only treated in part.

The bibliography relates not only to taxonomic works, but also to papers containing morphological, ecological, bionomical, and economic information; it is thus a very full one and runs to almost a thousand titles. The presence of keys, figures, and descriptions of nymphal stages is noted, and an outline of the distribution records is given under each species. It need scarcely be stressed that this comprehensive treatment extends the useful field of the catalogue beyond the domain of the taxonomist into the spheres of general and applied entomology. Thus many locust workers and any economic entomologist whose studies touch on the biology of grasshoppers should find these indexed references an invaluable source of information.

The text is set up in a commendably clear fashion, giving the greatest ease of reference and maintaining the high standard of consistency which must be demanded from a catalogue of this sort. In view of the general excellence of presentation it is regrettable that some of the conventions adopted in the text are not adequately explained in the introduction, and that certain mysterious anomalies have crept in. For example, the first citation of a synonym is given in italics, all other citations both of synonyms and the valid species name being in roman type; no mention of this is made in the introduction. The authority for a synonym, as the author states, is given in parenthesis after its citation; we are not told, however, why there is sometimes a parenthetical reference after the citation of a name which is valid (though we may presume, perhaps, that such a reference is to the citation of the valid name in a synonymic list). It seems particularly unfortunate in a work of great taxonomic importance that the author does not conform to Article 22 of the International Rules of Zoological Nomenclature, which requires that the name of the author of a zoological name be separated from the date of publication by a comma. This rule, which has survived all congressional amendments, seems a reasonable one, and taxonomists would have welcomed an explanation of its abandonment in this catalogue.

For the purpose of listing published distribution records the author groups the countries of the African continent into five distribution areas: North, West, East, Central, and South Africa; these he defines in extent by listing their component countries. The Cameroons are listed under "West Africa". It is not explained, however, whether the term "Cameroons" refers to the whole of the United Nations Trust Territory, under both British and French administration, or merely to the relatively small area which is governed by Nigeria. An examination of the text suggests that the former is the case, but this conflicts with the author's unqualified inclusion of French Equatorial Africa in "Central Africa". The issue could have been clarified by listing all the component territories of French Equatorial Africa separately, as the author has done with the colonies of French West Africa. Gambia and Basutoland might well have been mentioned, though one may easily infer the distribution areas to which they belong.

The use of the older name Truxalinae for the subfamily which is generally called Acridinae by modern workers creates, together with the retention of the Acrididae as the family name, a nomenclatural anomaly. If Truxalinae is used on the grounds of priority the family name should be Truxalidae for the same reason; if, on the other hand, Acrididae is retained as the name in current usage, it is reasonable to expect the same stem to be applied to the subfamily name. Indeed, one fervently hopes that the latter alternative will remain in general use, as acridologists would be justifiably disconcerted to find their subject converted by the upholders of priority into truxalidology.

It should be emphasized that such criticisms as have been made above relate to the author's overbrief explanation of his approach to the subject, and these minor failings, once recognized, should not detract from the great value of the catalogue itself. Mr. Johnston deserves the highest praise for the years of painstaking work which he has devoted to this immense task, and we can well understand that, when the text of the catalogue reached completion, he found it difficult to give quite the same degree of concentration to the explanatory notes of his introduction. The author should also be commended for the generally high standard of the proof-reading, though it is perhaps worth noting that in the contents all but the first of the tribes of the subfamily Pamphaginae are aligned with the subfamily name instead of being inset at the level of tribe.

In conclusion, one may glean from this catalogue an insight into the progress which has been made in the systematics of African grasshoppers during the past two centuries. In each successive quarter-century since the tenth edition of Linnæus's "Systema Naturae" (1758) the number of species to be newly described has increased. The total number of grasshoppers known from Africa has thus been increasing at a remarkable rate: in 1900 this number was in fact double what it was in 1875, and the present total is double the figure for 1900. The present rate of increase is about 300 new species per decade. Clearly, so far as the higher forms of taxonomy are concerned, the study of African grasshoppers is still in its infancy.

David R. Ragge

STRENGTH OF MATERIALS

Resistance of Materials

By Prof. Fred B. Seely and Prof. James O. Smith. Fourth edition. Pp. xvi+459. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 52*s*. net.

THE subject 'strength of materials' covers the study of the relations between applied loads and the stresses and strains caused by them in basic structural and machine elements; it is a fundamental part of all undergraduate courses in engineering and there are a large number of text-books dealing with it. When faced with a new book on such a well-documented subject the reviewer must therefore ask first whether the authors are justified in adding to an already extensive literature. The book under review is the fourth edition of a text-book first produced in 1925 by two professors of the University of Illinois; it has been extensively re-written and contains a good deal of additional material—it is therefore appropriate to think of it as a new book.

The book differs in two ways from many other text-books in this field. The authors explicitly define the relation of their subject to the basic subject of mechanics and direct the attention of students to the very important difference between methods of analysis and methods of design; and they do not limit their field of interest to the elastic behaviour of structural components. On these grounds alone the publication of this book is very welcome.

The authors make it clear to the reader, both by explicit statements and by the way in which problems are worked out, that this subject essentially deals with conditions of statical equilibrium and conditions of the compatibility of displacements; that the ultimate purpose is not only to determine the bending moments, shear forces, stresses, strains, etc., in an existing or specified structure, but also to determine the dimensions of structural components, suitable for their purpose: to carry specified loads without collapsing or without exceeding prescribed deformations. This realistic approach leads on naturally to the inclusion of sections on the inelastic behaviour of the basic structural components and, in fact, every chapter in the first part of the book contains separate sections on elastic and inelastic behaviour. The chapters of Part 1 deal with elementary topics: torsion, bending, the deflexion of beams by the moment–area method, combined axial and bending loads, the instability of columns, statically indeterminate members, analysis of stress, fatigue and dynamic loads. Part 2 covers the additional topics of composite beams, unsymmetrical bending and elastic vibrations of structural members, together with chapters on three further methods of obtaining the deflexion of beams: the double integration method, the conjugate-beam method, and the use of the theorem of three moments.

The inclusion of material not usually covered in elementary text-books has led to the exclusion of topics such as the analysis of strain and strain energy methods. In common with all American text-books I have seen (or for that matter most English text-books whose authors were not closely connected with the Department of Engineering of the University of Cambridge), the authors do not appear to be aware of the great economy of effort which is achieved by the use of Macaulay's[1] method when using the double-integration approach for the calculation of the deflexion of beams.

It is a common experience for university teachers to find that the introduction into undergraduate courses of new material based on recent developments is criticized by their colleagues on the grounds that this material involves new and difficult ideas. Fortunately these prophecies of doom are often proved false—the undergraduate to whom all the material is new does not share the prejudices of his elders, who can distinguish between what is familiar and unfamiliar to themselves. There seems no doubt that an elementary presentation of inelastic behaviour on the lines proposed by the authors of this book would enliven the teaching of strength of materials in the many universities where this has not yet been attempted and would not be found unduly difficult even by first-year students. E. K. FRANKL

[1] Macaulay, R., "Note on the Deflection of Beams", *Messenger of Mathematics*, **48**, 129 (1919). See also, for example, Southwell, R. V., "Theory of Elasticity", p. 187 (Oxford University Press, 1941); or Case, J., "Strength of Materials", p. 225 (Edward Arnold and Co., London, 1941).

FUNGICIDAL ACTION

Principles of Fungicidal Action

By Dr. James G. Horsfall. (A New Series of Plant Science Books, Vol. 30, issued under the auspices of the International Plant Science Publications Society.) Pp. xx+280. (Waltham, Mass.: Chronica Botanica Company; London: William Dawson and Sons, Ltd., 1956.) 6.50 dollars.

THIS book, by one who has long been the leader of a very prolific group in fungicide research, is a commentary rather than a text-book, although it covers the field remarkably well. It is a development of the author's earlier (1945) book, "Fungicides and their Action", issued by the same publishers, which gave considerable attention to the uses of the dosage–response curve and to problems of protectant fungicide application. The author is still impressed with the *DR* curve, as he calls it, but the four chapters on deposition, coverage and tenacity have been reduced to one. On the other hand, a good deal more can now be said about the mode of entry of a protectant fungicide into the spore or germ-tube of a fungus, and four chapters are devoted to problems of mobilization, permeation and intrinsic toxicity, and a paragraph in the earlier book on Zentmyer's observation of antagonism between oxine and zinc now becomes a chapter on chelation of needed metals, though the term 'chelation' is used rather broadly.

The enormous developments since the Second World War in organic fungicides are reflected in the inclusion of chapters on organo-sulphur compounds; ketones, including quinones; and heterocyclic compounds. In spite of the world-wide efforts to find substances suitable for chemotherapy, by which the author means attacking a pathogen already within the plant, there is suitable material for only one chapter on this El Dorado of biologist and chemist alike, a chapter longer than that in the previous book but concerned mainly with work published during 1950–54.

This stimulating book is somewhat marred by various signs of haste. Thus a little more care in proof-reading could have avoided a number of errors, particularly several misleading references to figures. Re-calculation would quickly have shown that the arithmetic on p. 49 is wildly inaccurate,

calling upon spores to defy the laws of matter and to occupy the same space; the logic in the penultimate line of that paragraph is also shaky. The author has confused phthalimide with phthalimidine; this seriously weakens his argument on pp. 205, 206 and 213.

There is, indeed, too great a tendency to extrapolate and to speculate from speculations. There is ample room in the laboratory and meetings for inspired guesses; I am not sure that there is a place for them in books where they so quickly become expired guesses. Fortunately, the author is very willing to admit past errors. The style is not improved by occasional lapses into current American *patois* which, contrary to intention, tend to reduce clarity, except perhaps to the local inhabitants.

Printers' errors are very few, and the type is much better than that used in the previous book. The table of contents is enlivened with some tantalizing facsimiles from various publications of historic interest; the list of illustrations is rather hidden at the end of the book.

The bibliography contains nearly 700 references, including a few from 1955, and there is an author index.

A. H. M. Kirby

MODERN CYTOLOGY

International Review of Cytology

Edited by G. H. Bourne and J. F. Danielli. Vol. 5. Pp. xii+570. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1956.) 11.50 dollars.

THIS book contains fourteen papers ranging from such subjects as the histochemistry of labelled antibody, enzyme adaptation in micro-organisms and the chemical composition of the bacterial cell wall, to the evolution of the mitochondrial nebenkern and the acrosome reaction. One reviewer alone could not cope with all this. It would be regrettable if the three papers mentioned above were overlooked by pathologists and bacteriologists because they appeared in a volume containing a round dozen of reviews on metazoon cell inclusions. The authors of these three useful papers are Albert Coons, of Harvard; C. S. Cummins, London Hospital Medical School; and J. Mandelstam, of the National Institute for Medical Research at Mill Hill.

The other papers are on more familiar cytological ground. There is a masterly review by Peter Caldwell, of University College, London, on the intracellular *p*H, the various methods being critically discussed. R. and C. Vendrely, of Strasbourg, have written on the results of cytophotometry of deoxyribonucleic acid in resting and dividing nuclei. These authors give a pleasing account of the work of that inspired investigator, T. Caspersson. This article and those on protoplasmic contractility in relation to gel structure by Douglas Marsland, of New York University, on the activity of enzymes in metabolism and transport in the red blood cell by T. A. J. Prankerd, of University College Hospital, and on the uptake and transfer of macromolecules by cells in growth and development written by A. M. Schechtman, of Los Angeles, all recall the editors' stated task—to form in the reading cytologist's mind a unified concept in this field. Schechtman's paper includes a review of the work of Brambell *et al.* on the passage of macromolecules in the mammal.

In 1942, Bensley began the analysis of the particulate constituents of the cytoplasm: from this emerged a type of cytological experimentation which, in the case of muscle, is here dealt with expertly by John W. Harman, of Wisconsin.

Junquiera and Hirsch of São Paulo, Brazil, have written on cell secretion based on the study of pancreas and salivary glands. They have dealt competently with some structural and many biochemical aspects of the work under review. Their report on microsomes, cell ribonucleic acid, and the information obtained by the use of radioactive isotopes is particularly lucid. Unfortunately, their description of the Golgi apparatus is much less satisfactory, and they have failed to present a clear-cut presentation of different theories of secretion. During recent years it has again been clearly shown by J. Dalton *et al.* and by D. Lacy in Hirsch's chosen material that the Golgi apparatus is not a number of discrete neutral-red or methylene-blue staining bodies, a theory strongly supported in the past by Hirsch. Both types of inclusions exist side by side in pancreas cells. Yet Junquiera and Hirsch have identified them as a single type of organelle. The confusion to which this has led in their review is difficult to describe.

Warren Andrews's paper on the mitochondria of the neurone reminds us of the debt we owe to E. V. Cowdry in this field; perhaps a perusal of T. Moussa's papers on the neurones of toads, etc., might have assisted Andrews in his section on recent observations. From Japan comes a well-illustrated and original contribution on acrosome reaction. This subject dates back to Popa's work in 1927; Afzelius's electron micrographs of sea urchin sperms are included by Jean E. Dan in this contribution. Vishwa Nath has collected his spermatogenesis work, mostly published previously in the Research Bulletin of East Panjab University and generally unknown in Britain. For fixed material, Nath and his pupils used exclusively Flemming-without-acetic and iron alum hæmatoxylin. Many of the points raised by Nath can now be settled by study of electron micrographs. We do not believe that mitochondria metamorphose into Golgi bodies. Nor do we believe with Nath that the *Lepisma* sperm is unique among insects in having its acrosome where its middle piece should be, a centriole at its tip in lieu of an acrosome, and no mitochondrial part. No doubt Nath will find further stimulus in the wonderful electron micrographs of spermatogenesis by Beams *et al.* and Afzelius.

Finally, we have to congratulate Fritiof S. Sjöstrand on his 78-page article on the ultra-structure of cells revealed by the electron microscope. For the non-cytologist teacher, and for the senior undergraduate facing 'Finals', this paper is unreservedly recommended as a straightforward non-controversial account of the subject. There is no doubt that some of the other contributors in this volume will be helped by reading Sjöstrand. As to nomenclature—are the γ-cytomembranes or agranular reticulum related to endoplasmic reticulum? So far as the reviewer can make out, this means 'Is the Golgi apparatus related to ergastoplasm (basophil substance of histologists)?' Finally, on fixation for electron microscope studies—Sjöstrand claims that the veronal–acetate buffer for osmium tetroxide (Palade) is not so important as originally claimed. The isotonicity and the accessibility of the fixative are now said to be more important. This has a familiar ring.

J. Brontë Gatenby

Bones for the Archaeologist

By Dr. I. W. Cornwall. Pp. 256. (London: Phoenix House, Ltd., 1956.) 50*s*. net.

ALTHOUGH the title of this book might at first glance suggest a light-hearted detective story, a suggestion which is perhaps enhanced by the gay picture on the cover of a skeletonized man on a skeletonized horse hunting a skeletonized stag with a skeletonized dog, it is a serious and systematic text-book designed to teach aspiring archæologists how to recognize and distinguish animal bones found in association with archæological relics. Detailed descriptions are given of the skull, dentition and limb bones of a variety of mammals likely to be found in palæolithic or later deposits, providing a useful key for their determination. Students will find that this text-book must be used essentially as a guide in the course of studying the actual skeletal elements described, for experience shows that, however careful and detailed the descriptive accounts may be, a learning of osteology is not to be acquired from books alone. The author has certainly done his work well so far as the systematic descriptions go, and he has incorporated useful sections dealing with the practical treatment of fossil bones in the field or in the laboratory. Except for those depicting the dentition of smaller creatures, which are rather too obscure, the illustrations are clear and precise, and in all cases the scale of drawing is indicated. A small point of criticism, perhaps of not great importance in a work of this kind, is that the author perpetuates a popular fallacy by his statement that it was Charles Darwin who first propounded the theory that all living species had developed from more primitive and simpler forms.

W. E. Le Gros Clark

The Bird Watcher's Reference Book

By Michael Lister. Pp. 256+16 plates. (London: Phoenix House, Ltd., 1956.) 45*s*. net.

USUALLY the authors of books written for bird-watchers occupy themselves with 'what' and 'how', devoting much space to descriptions of species, bird biology and field-work techniques. Mr. M. Lister does not follow this practice, devoting the general part of his book to problems which, although of great importance to every ornithologist, are seldom included in the bird books. Thus in this part of this ornithological book nothing is said about the bird itself, its life, behaviour, etc. Instead of this, the first four chapters deal with "Habitats, Vegetation, and Birds", "Types of British Vegetation", "Weather" and "On Writing a Paper". All matters discussed here are of great interest for every ornithologist and it is very good indeed that, at last, they have been presented to him in detail. Chapter 5—"Directory"—contains information referring to periodicals, institutions, bird observatories and ringing schemes, in almost every country of the world. The amount of information gathered by the author shows how much effort and labour had to be made to reach such an excellent result. Objection could be raised only with reference to North American ornithological life, which seems to be treated with a little less care; but on the whole this directory is probably the most comprehensive ever published. Chapter 6—"Glossary and General Reference Section"—embraces explanations of about seven hundred terms used in ornithological literature together with their German, Dutch and French equivalents. This glossary should render good service, especially for non-professional ornithologists. Appendix 1 contains the "Classification of the Habitats of British Birds", by W. B. Yapp; Appendix 2 lists 648 ornithological and zoological periodicals arranged alphabetically. Bibliography and very detailed indexes (57 pages) close this extremely useful and important book.

W. Rydzewski

Principles of Physical Metallurgy

By Morton C. Smith. Pp. xii+417. (New York: Harper and Brothers; London: Constable and Co., Ltd., 1956.) 50*s*. net.

Alloy Series in Physical Metallurgy

By Morton C. Smith. Pp. x+338. (New York: Harper and Brothers; London: Constable and Co., Ltd., 1956.) 50*s*. net.

THESE two volumes may be taken as constituting a general account of physical metallurgy at introductory level. They would serve satisfactorily as a student's text. "The Principles of Physical Metallurgy" deals with general principles, namely, atomic considerations, crystallography, electrical and magnetic properties, and the various effects of stress on metals, including details of fracture. Some idea is also given of the types of phases present in metals. However, phase equilibria and alloying comprise the subject-matter of "Alloy Series in Physical Metallurgy", in which binary equilibrium diagrams are thoroughly discussed, followed by consideration of the structure and heat treatment of steel, and then of the cast irons, although important non-ferrous alloys are not covered to the same extent. Finally, ternary systems are briefly described and mention is made of quaternary systems.

The subject-matter included and its treatment are in the main quite conventional, although the author apparently claims some originality in these directions. One might quarrel over small points but the text is generally sound. The style of writing is sometimes laborious, the development rather drawn out, and illustrations are not always used economically.

A. R. Bailey

German-English Mathematical Vocabulary

By Dr. Sheila Macintyre and Edith Witte. With a Grammatical Sketch by Lilias W. Brebner. (University Mathematical Texts.) Pp. xi+95. (Edinburgh and London: Oliver and Boyd, Ltd.; New York: Interscience Publishers, Inc., 1956.) 8*s*. 6*d*. net.

THE young mathematician, obliged to learn enough German for professional reading, would be well advised to purchase this little book. A careful study of the thirty-page grammatical sketch, coupled with conscientious reference to the two thousand words of the skilfully selected vocabulary, should enable him to read most German mathematical works with readiness, although, of course, it will not equip him to skim a newspaper or enjoy a novel. A good plan would be to begin with one of Landau's tersely written works, and go on from there to more verbose authors. An admirable feature of the present book is a page from Ince's "Integration of Ordinary Differential Equations" faced by the corresponding page of the authorized German translation, and two similar pages from Gillespie's "Integration" and its translation. The pure mathematician will be grateful for this addition to the series of University Mathematical Texts; the applied mathematician, the mathematical physicist, the statistician, may wish for a companion volume.

T. A. A. Broadbent

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

ROYAL VISIT

H.M. the Queen and H.R.H. Prince Philip, Duke of Edinburgh, visited the Atomic Energy Research Establishment, Harwell, on March 1, at a very interesting time in its history. In the late summer of 1956 the Queen turned the switch which sent nuclear-generated electricity into the National Grid of Great Britain for the first time. Since then, industrial firms have begun to build the first three commercial nuclear power stations for which Calder Hall was the prototype. The immediate task of the Establishment is now to assist in the development of more efficient versions of the gas-cooled graphite-moderated reactor and to do basic research and development work on those advanced types of reactor systems which might ultimately replace the simpler Calder Hall type of reactor. During the visit the Queen and the Duke of Edinburgh were shown some of the more striking technological work being carried out in this reactor research programme. They were also shown some of the long-term experimental work going on into the possibility of generating power from the thermonuclear fusion reaction.

The tour of the DIDO reactor took place about four months after its official opening by the president of the Royal Society, Sir Cyril Hinshelwood. The main purpose in designing and building this reactor is to provide regions in which possible fuel elements, and other constructional materials for future reactor systems, can be studied under conditions of intense irradiation. Irradiation inside a nuclear reactor considerably alters the properties of possible fuels; for example, uranium begins to 'creep' at a lower stress under irradiation than that required to cause creep on the bench. Also, the generation of fission products within the fuel may cause profound structural alterations within the element; for example, the evolution of gaseous fission products may even cause swelling. In addition, corrosion-rates and rates of chemical reactions between possible reactor materials are frequently significantly altered under these conditions.

Experiments on these problems in the early stages of research can often be done on the small scale, but as development progresses it is essential to investigate the behaviour of the proposed components of a future reactor channel (complete with fuel elements) in a test system mounted in elaborately designed holes built into the core of a testing reactor such as DIDO. DIDO is a heavy-water moderated reactor and is fuelled by enriched uranium; it was designed to give the highest radiation flux over a large accessible core volume consistent with a limited heat output. The available neutron flux is 10^{14} n./cm.^{2}/sec. at a heat output of 10 MW. Three of the holes built into the core are designed to accept test systems which are virtually complete reactor 'channels' together with the ancillary engineering equipment; these large-scale experiments are called engineering 'hot loops'. (PLUTO, a similar reactor to DIDO, which will start operating this year, is specially designed to accommodate 'hot loops'.) Other holes in DIDO are designed to hold equipment for testing systems at earlier stages of development.

Although many of the problems planned for study in DIDO are simple in principle, the design of the apparatus is complicated by the need to control and record externally the temperature and the other reaction conditions inside a confined space within the core. In addition, the materials of construction have to be selected from those which have small neutron capture cross-sections and which are also stable under the expected irradiation conditions. Experience in the design and use of apparatus of this kind was first gained using BEPO; some of the equipment used in these experiments was shown during the open days at the Establishment last year (see *Nature*, **177**, 1195; 1956).

Samples of fuel removed from the reactor for metallurgical study after irradiation are highly radioactive and can only be safely handled inside 'cells' with shielding walls made of lead or concrete. Metallurgical examination of specimens inside cells of this kind is done by using a specially designed television microscope; preparation of the specimens before examination requires a sequence of connected cells in which the essential operations can be carried out. Chemical operations inside cells of this kind can be done by using large 'master-slave' manipulators in which the slave 'grab' within the cell faithfully copies the movement of the hand in the master 'grip' outside it by mechanical transmission through a tube high in the wall of the cell. The work inside the cells is viewed through special 'windows'; these are transparent glass tanks filled with a concentrated aqueous solution of zinc bromide having a physical density equivalent to that of concrete. The delicacy of operation of a pair of manipulators in a typical handling cell was demonstrated to the Royal party by lighting a candle with a match taken from a matchbox within the cell. DIDO is also used for fundamental studies in solid-state physics, neutron physics and radiation chemistry; radioactive cobalt-60 for medical use is made in special irradiation units in which a large number of cobalt disks can be irradiated simultaneously; these units are like the experimental irradiation assemblies.

The LIDO reactor was opened at the same time as the DIDO reactor; its purpose, however, is quite different. The reactor core is suspended in a large concrete tank of water from a trolley which can be moved to and fro down the length of the tank. Two aluminium panels are set into the base of the concrete tanks so that experiments to study the design of light-weight reactor shielding for propulsion reactors can be set up in front of the panels. During the tour of LIDO, the Royal party saw the progress of the work directed towards the development of the British nuclear-powered submarine. The work is being done by an Admiralty team in association with the Establishment.

In the plutonium laboratory of the radiochemical building, the study of the chemistry and metallurgy of the unusual materials of atomic energy was shown. Plutonium and its compounds do not emit penetrating radiation, but are highly toxic materials. For this reason the work is confined to sealed glove boxes

in which every chemical or metallurgical operation required can be carried out.

Since it is expected that plutonium will be used to fuel future reactor systems, the study of the detailed chemistry and metallurgy of plutonium, its compounds and alloys is very important from a technological point of view; in addition, more basic studies of the chemistry of plutonium and other transuranic elements are carried out. Before leaving the laboratory, the Royal party were shown some of the results of research into methods for fabricating materials like uranium and thorium or beryllium and zirconium into forms which withstand the intense radiation conditions inside nuclear reactors. In particular, powder metallurgical methods have proved to be extremely important in this field.

The Royal party were also shown some of the experimental work which is being done at the Establishment directed towards the ultimate use of controlled thermonuclear reactions as a source of power. It is hoped to summarize the essential problems in this very interesting work shortly in *Nature*.

A. H. S. MATTERSON

HOME UNIVERSITIES CONFERENCE

Organization of Postgraduate Studies

THE subject for the second session of the Home Universities Conference held in London during December 14–15 was "Organization of Postgraduate Studies". Sir James Mountford, vice-chancellor of the University of Liverpool, gave the opening address and surveyed the problem with a light touch. His comment that in arts the Ph.D. student is a relatively rare bird foreshadowed a discussion that concerned in the main the problems of scientists. He feared that with much organization there was little or no room for the student with 'a private hunch' in science departments.

He was followed by Dr. D. A. Bell, Department of Electrical Engineering, University of Birmingham, who emphasized the value of the M.Sc. degree by examination. Dr. Bell considers that while industry obviously needs the first-class man, it can also make use of the good honours man who has had postgraduate training. Dr. Bell also directed attention to the difficulties of organizing fundamental research in fields where research needs a staff of technicians as well as large and expensive apparatus.

Prof. F. S. Dainton, professor of physical chemistry, University of Leeds, showed an appreciation of the problem of selection of students for postgraduate research work, and felt that note should be taken of the quality of "persistence under adversity". He drew an interesting comparison between educational practice in universities in Britain and in the United States of America. He emphasized the value to the student of changing his university after his first degree, but made it clear that in the United States the interval between the first degree and the Ph.D. is sometimes four and often five years. Prof. Dainton doubted if the number of Ph.D. students should increase as rapidly as the number of those trained in directed research.

Prof. E. R. H. Jones, of the University of Oxford, welcomed the decision of the Department of Scientific and Industrial Research to give grants for students taking postgraduate diplomas. He thought that the training of postgraduate students in science should include training in methods of communicating results. Migration of senior postgraduate students from one university to another would be encouraged if there were more research awards for those who had already obtained the Ph.D. degree. He associated with this a plea that there be an increase in the number of postgraduate science students given permanent deferment from national service.

The discussion that followed emphasized the length of time needed to train the independent research worker. It was accepted that if notice was to be taken of the morning discussion, which had emphasized the overloading of the curricula of undergraduate studies, more would have to be done after the first degree. There was also considerable support for giving some training in the methods of research to those who might never become independent research workers.

Prof. J. G. Semple, of King's College, London, proposed a new 'Certificate of Advanced Studies'. Lord Chorley made it clear that the problem concerns law students as well as scientists, and that postgraduate training in law is increasingly demanded by the profession and by government departments.

Technology and the Universities

The third session of the Conference was devoted to the "Impact on the Universities of the Government's Policy for the Expansion of Technological Education". Three papers were presented and there was a lively discussion. Sir Eric Ashby, president and vice-chancellor of The Queen's University, Belfast, opened the session. He drew a parallel between the present upsurge of technological education and the upsurge of scientific education about a century ago. Competition from the proposed new colleges of technology, an increase in the prestige (and cost) of faculties of technology, and greater dependence on government finance—all these are problems for which there are precedents and for which it should not be difficult to devise solutions. But there remain two problems for which there are no precedents: one is the future faculties of arts, and the other is the place of humanities in faculties of technology.

These problems, though not new, now require solution urgently, for they are brought to a head by the expansion and encouragement of higher technological education. There are no precedents for them, because until recently the viability of faculties of arts was assured by the 'market-value' of arts degrees in the Civil Service and elsewhere; and technologists rarely attained positions of administrative responsibility, so that they were not obviously handicapped by their lack of any formal training in the humanities. The social climate has now entirely changed. In so far as faculties of arts pursue scholarship and train scholars, their place in universities is secure. But the greater part of their time is not spent on either of these activities, and it is their 'bread and butter lines' which need re-examination in the light of present Government policy.

As to technologists, Sir Eric gave some evidence to indicate that more than a quarter of them end up in administration, for which some familiarity with arts subjects is quite essential. Technology is in any event inseparable from humanism, for it is the application of science to man and society. Sir Eric proposed two remedies: the first, that courses in such subjects as political institutions, economic history, social anthropology, and jurisprudence, should be obligatory ingredients of university courses in technology; the second, that arts faculties should secure their viability by ensuring that their own graduates are familiar with the contemporary problems of civilization, and at the same time by providing essential courses for faculties of science and technology. This would involve raising the "ivory curtains between faculties".

Sir Harry Pilkington, chairman of the National Advisory Council for Industry and Commerce, emphasized that the responsibility of universities is to place technology in perspective as a servant of the community and not as a subject to be studied for its own sake. He would like to see the sharp division between science and arts at the universities deliberately blurred; he agreed with Sir Eric Ashby that university education should cut across faculties. Another important point made by Sir Harry Pilkington was that industry requires among its technologists not only specialists but also men with imaginative and creative casts of mind; universities must produce the thinkers for industry. The very successes of industry in solving technological problems will give rise to new demands for non-material needs, in literature and the arts, for example; and the country will look to the universities to satisfy these needs too. Finally, Sir Harry mentioned the impact on the universities of the inevitable improvement in the prestige of industrial work for graduates; as they come to realize that industry is neither dirty nor dull, some of the best scientists will certainly be attracted to industry away from universities.

The third paper was from Dr. Willis Jackson, of Metropolitan-Vickers Electrical Co., Ltd., who is chairman of the Joint Committee on the Supply and Training of Teachers for Technical Colleges. Dr. Jackson directed attention to a difficulty inherent in modern training in higher technology, namely, that technologists must, on one hand, become increasingly specialized and, on the other hand, must recognize the interdependence of different specialisms when technological problems have to be solved. In Dr. Jackson's view, universities should concentrate their curricula upon basic science and interdepartmental activities, leaving it to industry to supply training in narrow specialist fields. One of the chief problems facing faculties of technology, Dr. Jackson said, will be the recruitment of staff; for an able young technologist wants to practise technology, not to teach it. This problem might be solved by two means: first, academic men should more commonly be appointed as consultants in industry, and from time to time should spend periods of full-time work in industry; secondly, universities should draw upon industry for visiting lecturers—not simply to give occasional lectures but to give complete and examinable courses to technology students. One obstacle to a closer integration between teaching and practice in technology is the fact that pension schemes are not ordinarily transferable between industry and universities; this obstacle should be removed.

During the discussion, Prof. J. Greig (King's College, London) asked universities to be prepared to recognize (with suitable safeguards) the new diploma in technology as a qualification allowing students to work for higher degrees. Mr. J. W. Gray (Queen's University, Belfast) challenged Sir Eric Ashby's suggestion that the contribution of arts faculties to faculties of technology should be confined to studies of contemporary society: it is often preferable to introduce students to unfamiliar civilizations. Prof. A. H. Naylor (Queen's University, Belfast) suggested that students with a better background in humane studies would be recruited into faculties of technology, if these faculties were prepared to forgo their special faculty requirements. Prof. A. F. Burstall (Newcastle upon Tyne) supported the plea for formal courses in the humanities for engineering students; and it was mentioned that the faculties of economics and law also have contributions to make to technological education. A very interesting contribution was made by Prof. J. J. Auchmuty, who is dean of the Faculty of Humanities in the New South Wales University of Technology. He is engaged in doing precisely what Sir Eric Ashby proposed should be done in British universities, for in the New South Wales University of Technology all students are obliged to study English, history and psychology. The chief difficulty, Prof. Auchmuty said, is to recruit suitable staff, and he considered that it will become necessary to institute a faculty of arts in the University of Technology in order to provide cohesion and stimulus for the humanities.

RADIO STAR SCINTILLATIONS AND INTERSTELLAR HYDROGEN

By Dr. G. A. HARROWER
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IT is generally believed that the scintillation of a radio star is the result of irregularities in the density of ionization at a height of about 400 km. which move with a wind-like motion past the observer's line of sight[1]. Two general questions remain unanswered: the question of what agent or agents may contribute to this ionization, and the question of whether the ionization is produced in an irregular pattern or becomes irregular after its production, perhaps due to turbulence. The work reported here was undertaken with the hope of obtaining at least a partial answer to the first of these questions.

At Ottawa during 1954, the radio signal from the strong source in Cassiopeia was recorded practically continuously at a frequency of 50 Mc./s. The records were examined and judged to show scintillations, or not, for each hourly interval. The most prominent

variation in the percentage occurrence of scintillations was easily seen to depend on the altitude of the source, with the occurrence being a maximum at lower transit and a minimum at upper transit. Grouping the measured data in eight categories, corresponding to eight equally spaced positions of Cassiopeia on its diurnal circle, allowed the altitude effect to be removed. Thereafter, the year was divided into twenty-four approximately 15-day periods, and for each of these a plot was made of variation in percentage occurrence of scintillations against solar hour of the day as shown in Fig. 1. Each of these twenty-four graphs shows two or three broad maxima at certain hours of the day; these hours of maximum scintillation changed systematically throughout the year. They comprised five features as follows: from approximately September 13 to March 30, scintillations reached a maximum at the nearly constant hour at 0300 (feature *A*) and displayed a second maximum at hours between 1500 and 2100 (feature *E*); for the remainder of the year a maximum occurred between 2100 and 2400 hours (feature *F*), and in addition two features (*B* and *C*), less prominent than those already mentioned, were present between the hours of 0600 and 1300. This division of the year into two parts and the lack of circular symmetry with respect to the Sun suggest that the Sun is not primarily responsible for the variations observed, but rather, as has been suggested before[2,3], a mechanism external to the solar system should be considered.

The suggestion is made here that interstellar particles captured by the Sun's gravitational field can explain the scintillation measurements. The accretion of interstellar matter by a star has been studied by Hoyle and Lyttleton[4]. The Sun, moving through a cloud of particles, will deflect these particles, forming, with the help of many inter-particle collisions, a relatively dense accumulation of particles behind itself. The situation is shown schematically in Fig. 2. From this so-called collision region, particles fall toward the Sun. If such particles striking the Earth's atmosphere contribute to the ionization responsible for scintillations, the solar hour of the day of maximum occurrence of scintillations corresponds to a most nearly perpendicular incidence of the infalling particles. It is possible, therefore, to proceed from solar hour of maximum scintillation, through a correction for the Earth's orbital velocity, to direction of the component of the velocity of infalling particles in the Earth's equatorial plane. These directions of arrival of particles, derived from the scintillation measurements, are shown in Fig. 2 for twenty-four positions of the Earth on its orbit, having been corrected for the Earth's orbital motion.

Such an analysis serves to identify feature *A* mentioned above, with particles falling radially toward the Sun from the collision region. Their speed is calculated (making use of the Earth's known orbital velocity) to be $3{\cdot}3 \times 10^4$ m./s., and in addition, the collision region is calculated to be 200 million miles from the Sun. This last number falls satisfactorily within the outer limit for the Sun's collision region of 400 million miles derived from the Hoyle and Lyttleton theory. The *E* feature, which occurs along with the *A* feature, is considered possibly to result from *A* particles being accreted by the Earth's gravitational field. The *B* and *C* features are believed due to particles leaving the collision region with sufficient tangential velocity to miss the Sun, crossing the Earth's orbit and striking the Earth when it is on the side of the Sun opposite the collision region.

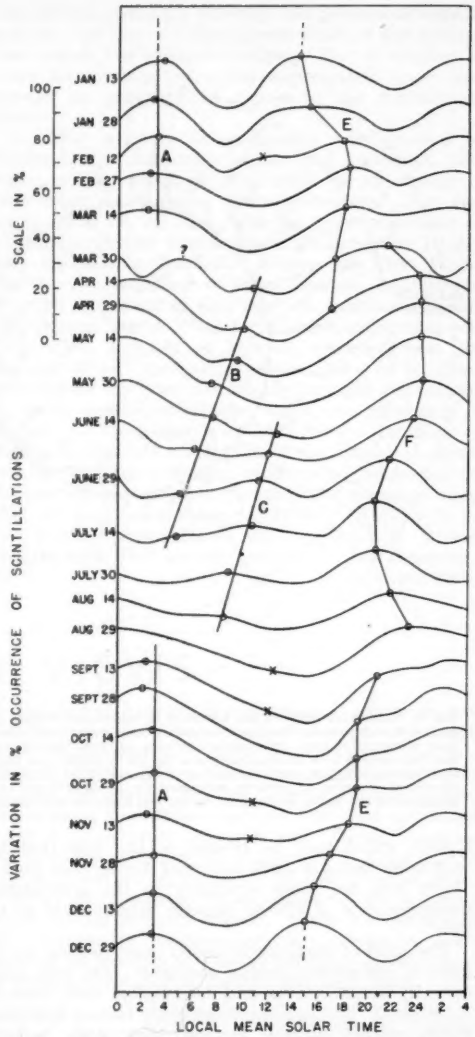

Fig. 1. Variation in percentage occurrence of scintillations against local mean solar time for twenty-four approximately 15-day intervals throughout the year 1954. A common ordinate scale is given in the upper left corner. Each of the twenty-four curves shows two or three maxima, which are grouped into features *A*, *B*, *C*, *F* and *E*. These features are believed to be attributable to the accretion of interstellar matter by the Sun, and the points marked with crosses are believed due to particles coming directly from the Sun

The *F* feature is assumed to result from the direct infall of interstellar particles toward the Sun.

In addition to the effects just mentioned, there were three periods during the year when the scintillation record reached a maximum near 1200 hr., suggesting the arrival of particles from the Sun. These occasions are marked with crosses on the graphs of Fig. 1. On two of these occasions (February and October–November) particle speeds of about 2×10^3 m./s. were calculated from the observations, and these two periods coincided with the two broad maxima which were displayed by the planetary *K* index during 1954. On the third occasion (August–September) the speed of the particles was very much

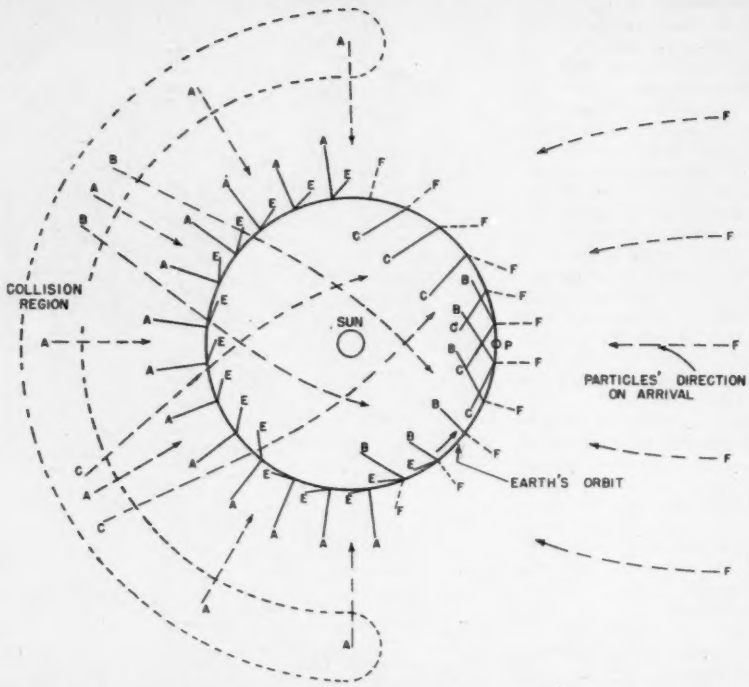

Fig. 2. Connexion between the accretion of interstellar matter by the Sun and the observed scintillations of radio stars. The Earth traverses its circular orbit about the Sun and is at the point *P* on June 8 approximately. Interstellar particles, arriving from the right, form a collision region behind the Sun—shown here schematically as a dotted hemispherical region. Particles arriving both directly and from the collision region are believed responsible for the scintillation observations. The apparent directions of arrival of particles (corrected for the Earth's orbital motion) are shown for twenty-four positions of the Earth on its orbit, as derived from the scintillation measurements presented in Fig. 1

higher, which may be related to the fact that the only solar flares of 1954 occurred during that period. There was no other evidence in the scintillation measurements of effects directly attributable to the Sun.

The kind of particles involved must depend on the kind of interstellar matter available. On that basis, only hydrogen atoms and interstellar dust need be considered. Two arguments strongly favour hydrogen. First, meteor studies suggest that dust particles produce ionization only at altitudes lower than the 400-km. level believed to be important here; and further, show no correlation between meteor activity and radio star scintillations. Secondly, the Sun's radiation pressure would remove small dust particles from its vicinity while allowing hydrogen atoms to fall inward.

Combining information about solar times of maximum occurrence of scintillations with the observed annual variation (the Earth is determined to be on the forward side of the Sun on June 8) allows the celestial radiant of the infalling hydrogen to be estimated. The radiant appears to lie within the limits: right ascension 16 h. 40 m. to 17 h. and declination $-20°$ to $-40°$. In addition, the components of the velocity of the particles with respect to the galactic plane can be estimated as follows: tangential, 28×10^4 m./s. (the particles are judged to be overtaking the Sun from behind), radially outward 2×10^4 m./s., and transverse $0{\cdot}2 \times 10^4$ m./s.

A detailed account of these measurements and the analysis performed will be published elsewhere.

The scintillation measurements used here were made by T. R. Hartz, who also, with P. A. Forsyth and C. O. Hines, gave much helpful advice. The work was carried out at the Radio Physics Laboratory of the Defence Research Board, Ottawa.

[1] Hewish, A., *Proc. Roy. Soc.*, A, **214**, 494 (1952).
[2] Ryle, M., and Hewish, A., *Mon. Not. Roy. Astro. Soc.*, **110**, 381 (1950).
[3] Ginzburg, V. L., *Dok. Acad. Nauk, U.R.S.S.*, **84**, 245 (1952).
[4] Hoyle, F., and Lyttleton, R. A., *Proc. Camb. Phil. Soc.* **35**, 405 and 592 (1939).

OBITUARY

Prof. R. N. Rudmose Brown

Dr. Robert Neal Rudmose Brown, emeritus professor of geography in the University of Sheffield, died on January 27 in his seventy-eighth year. Born on September 13, 1879, he was educated at Dulwich College, the University of Aberdeen and the University of Montpellier. By training, a botanist with a strong inclination for field-study, he held the post of assistant professor of botany in University College, Dundee, during 1900–2. But he yearned for exploration and in 1902 was appointed naturalist to the Scottish National Antarctic Expedition, which for two years sounded and charted 10,000 miles of unexplored Antarctic seas. For his part in this work he was awarded the Medal of the Royal Scottish Geographical Society.

In 1904 he was appointed assistant at the Scottish Oceanographical Laboratory, and in 1906 visited Burma to report to the Government of India on the pearl oyster fisheries of the Mergui Archipelago. Later, in 1909, 1914 and 1919, he served as surveyor and naturalist on three Scottish Arctic expeditions to Spitsbergen, on which region he became an acknowledged authority and for which work he was awarded the Cuthbert Peak Grant of the Royal Geographical Society. His interest in polar regions never waned. In 1907 he was elected vice-president of the International Polar Congress; in 1932 president of the Antarctic Club, and in 1949 of the Arctic Club.

In the earlier years of his career Rudmose Brown was much influenced by the thought and teaching of Patrick Geddes, and by some of the earliest pioneer teachers of geography—a new subject that was then only just emerging, at the beginning of the century, to replace the teaching of 'capes and bays'. When, in 1908, the University of Sheffield took, for that time, the very progressive step of creating a Department of Geography, Rudmose Brown was appointed its first head. The development of the new subject and the new Department became his life's work, and he will always be remembered as one of the leading pioneer teachers in that field, who did much to promote the status of geography as an academic discipline in Britain, through the critical early decades of its development. From the start he placed great emphasis on the importance of the physical basis as the foundation and core of the subject, to which human and regional studies must be welded later, and his approach gave the work of his Department at Sheffield a distinctive character.

His own numerous published researches were mainly concerned with polar geography, on which he wrote many texts of acknowledged standing. But his scholarship and interests covered very many fields, and included a standard text-book of economic geography, and a contribution to a text-book on the scope and teaching of the subject. As a lecturer he was renowned for his lucidity and powers of exposition, no less than for the diverse fields of the subject over which his interests ranged. For a number of years he contributed much appreciated notes and articles on geographical topics to the columns of *Nature*.

In 1931 a chair of geography was created at Sheffield, and Rudmose Brown was appointed professor, a post which he held until his retirement in 1945 after thirty-seven years of service. For two years, 1920–22, he also held the post of reader in geography in the University of Manchester, jointly with his post in Sheffield. During the First World War he was seconded to the Admiralty Intelligence Division and some of this work he continued during the Second World War, for which confidential services King Haakon of Norway awarded him the insignia of the Commander of the Order of St. Olav.

Rudmose Brown's scholarship brought recognition in many academic spheres. He was president of Section E (Geography) in 1927 and a member of Council from 1933 until 1938 of the British Association for the Advancement of Science; he served on the Council of the Royal Geographical Society during 1925–28, and again during 1945–46. In 1938–39 he was elected president of the Institute of British Geographers—the second holder of this important office.

A. GARNETT

NEWS and VIEWS

Ministry of Supply: Aircraft Mechanical Engineering: Mr. Robert Graham, C.B.E.

MR. ROBERT GRAHAM retired from the post of director of Aircraft Mechanical Engineering Research and Development, with the Ministry of Supply, in January 1957, after thirty-nine years of government service. He was born in Glasgow in 1894 and after attending the Gateshead Secondary School and Darlington Technical College, served an engineering apprenticeship with Messrs. Robert Stephenson, locomotive builders, at Darlington: his apprenticeship was broken by two years overseas service in H.M. Forces. Mr. Graham joined the government service under the Air Board in 1917. In 1920 he was seconded to act as chief engineer to Mr. Louis Brennan, who was designing and developing the Brennan helicopter under Air Ministry sponsorship. The aircraft was completed in 1925 and Mr. Graham acted as test pilot throughout its trials. Although the aircraft showed considerable promise and a number of short free flights were made, it was decided to abandon the project, following damage in a minor accident, because the Air Ministry was advised that the autogyro held more promise of success than the helicopter. In 1926, Mr. Graham joined the Airworthiness Department of the Royal Aircraft Establishment, but maintained a private collaboration with Brennan in the development of a gyroscopically stabilized two-wheeled motor-car. A successful vehicle was produced but it was found that all such vehicles suffered from an inherent disability which made them unsafe for use on the public highway, and the project was abandoned. After serving during 1928–38 as resident technical officer at some of the major aircraft firms, Mr. Graham was put in charge of the Mechanical Engineering Division of the Structures and Mechanical Engineering Department at the Royal Aircraft Establishment, where he was chiefly engaged on research into pressure cabins and other equipment for high-altitude flying and into aircrew safety. When the Department was split up in 1946, he became the first head of the Mechanical Engineering Department and in 1950 was appointed director of aircraft research and development at the Ministry of Supply headquarters in London. In a subsequent re-organization of the London headquarters, Mr. Graham was appointed to the post from which he has recently retired. Since his retirement Mr. Graham is maintaining his interest in aeronautical engineering and has taken up an appointment as technical director of Messrs. Microcell, Ltd.

Mr. E. A. Poulton

MR. E. A. POULTON has been appointed to the post of director of aircraft mechanical engineering equipment research and development at the Ministry of Supply in succession to Mr. R. Graham. Born in 1915, Mr. Poulton was educated at Bournemouth School and Bournemouth Municipal College. He gained a Royal Scholarship to the City and Guilds College, where he graduated in mechanical engineering with first-class honours in 1937. After a year's postgraduate study in aeronautics he joined the Supermarine Works of Vickers-Armstrongs, Ltd., and later became technical officer to the Air Registration Board. With the cessation of civil aviation in the early months of the War he transferred to the Royal Aircraft Establishment and, later, to the Ministry of Aircraft Production headquarters, where his main objective was to shorten the period between new research discoveries and their application in aircraft design. In February 1946 he returned to the Royal Aircraft Establishment and became superintendent of the Structural Research Division. His

next task was to re-establish research work on aircraft airworthiness, and he held the post of superintendent of the Airworthiness Division for four years. In July 1951 he went to the Ministry of Supply headquarters to become deputy director, and later director, of aircraft research and development. Mr. Poulton is well known in the aircraft industry for his long association with the Joint Airworthiness Committee, of which he is still chairman.

University of Sydney: Visiting Professor of Pharmacology

Prof. J. M. Robson, who is professor of pharmacology at Guy's Hospital Medical School, London, has been appointed as the 1957 visiting professor of pharmacology in the University of Sydney. The pharmaceutical manufacturers of Australia have established a fund to enable the University to invite a guest professor in this subject each year. Prof. Robson is joint author of "Recent Advances in Pharmacology", and is an active research worker in chemotherapy, particularly in connexion with tuberculosis. He will leave for Australia early in April and return via the United States early in June. During his stay in Australia he will lecture in Sydney and other capital cities, and will visit the Australian National University in Canberra.

City and Guilds of London Institute: Fellowships

The Council of the City and Guilds of London Institute has conferred the Fellowship of the Institute (F.C.G.I.) upon the following past students of the City and Guilds College or Finsbury Technical College in recognition of their distinguished contributions to industry or the professions in which they are engaged: H. Drew, chief engineer, General Motors Overseas Operations (formerly director and chief engineer, Vauxhall Motors, Ltd.); R. J. Halsey, assistant engineer-in-chief, General Post Office; A. M. R. Montagu, consultant on irrigation and hydraulics, with Sir Murdoch MacDonald and Partners, consulting engineers, London; G. W. Tookey, barrister-at-law.

Royal Scottish Museum: Appointment

The retirement has been announced of Mr. A. R. Hutchieson, keeper of the Department of Technology in the Royal Scottish Museum since 1934. Under his administration, the Department made great progress in the artistic and educative display of technological material, often of a most intractable nature. He is succeeded by Mr. R. W. Plenderleith, who has been assistant keeper of the Department since August 1935. Mr. Plenderleith has been conspicuously successful in designing working exhibits able to stand up to heavy public usage, and has introduced many novel ideas in museum audience participation in the field of the applied and physical sciences.

University Grants in Britain for 1957–62

In the House of Commons on March 14, the Chancellor of the Exchequer said that he has been considering recommendations made to him by the University Grants Committee for grants for the ensuing five years when the present quinquennial settlement expires next July. He is satisfied that an increase in grant is necessary to enable the universities to maintain the present level of activity. Taking into account both the growing number of qualified applicants for admission and the importance of the output of graduates at a time when the need for highly trained people in business, industry, administration, teaching and research is increasing, and when it is necessary for us to keep in the forefront of scientific and technological development, and the financial and economic difficulties of Britain which call for general restraint, he proposes to invite Parliament to vote the following recurrent grants for the five university years beginning on August 1 next:

1957–58	£30,600,000
1958–59	£32,300,000
1959–60	£34,350,000
1960–61	£36,750,000
1961–62	£39,500,000

These sums do not include, the Chancellor said, provision for non-recurrent grants towards capital expenditure and take no account of the recently announced improvements in academic salaries.

Colleges of Advanced Technology

Replying to a question in the House of Commons on March 14, Sir Edward Boyle, Parliamentary Secretary to the Ministry of Education, said that eight technical colleges have now been designated as colleges of advanced technology. They are as follows: Birmingham College of Technology; Bradford Technical College; Cardiff College of Technology and Commerce; Loughborough College of Technology; the Royal Technical College, Salford; and, in London, the Battersea, Chelsea and Northampton Polytechnics.

University College of Rhodesia and Nyasaland

The University College of Rhodesia and Nyasaland opened its doors on Monday, March 4. The total number of students registered was seventy-four —forty-three men and thirty-one women—including seven African men and one African woman. Of the seventeen men and twelve women entered for the postgraduate course in education at the College, three are African men students and one is an Indian woman student living in Southern Rhodesia. The rest of the students are studying for the B.A. (General) degree of the University of London (twenty-seven students), and for the B.Sc. (General) degree of the University of London (eighteen students). Most of the students are in residence at the College, the European men being accommodated in the Manfred Hodson Hall of Residence, and the African men in the Carr-Saunders Hall of Residence. The number of students registered at the start of the College is greater than was expected, and for the next academical year it is estimated that the intake will be about 120. This means that the anticipated total of 200 students during the fifth year of the College's life will in fact be reached, and exceeded by the third year. The acceleration of the plans for building, and for the additional expenditure thus needed, are under consideration.

The funds which are available or which have been promised, and which are committed for present necessary capital expenditure, are as follows:

Grant from the Government of the United Kingdom (Colonial Development and Welfare Fund)	£1,400,000
Grants from the Territorial Governments of the Federation of Rhodesia and Nyasaland	£100,000
Grant from the British South Africa Company and the Anglo-American and Rhodesian Selection Trust Organizations	£150,000
Contributions from other bodies and the general public of the Federation of Rhodesia and Nyasaland	£250,000

Recurrent expenditure will be met by an average grant of £150,000 a year for the next five years, from the Government of the Federation of Rhodesia and Nyasaland. There is also a grant for education from the Carnegie Corporation of £30,000 spread over five years, while an Oppenheimer Grant of £2,000 a year for seven years provides for a lecturer in Portuguese. Estimates suggest that another £1,250,000 is required to place the University College in a position to meet the demands which will arise during its first decade of existence. It is to be hoped that the financial problems of this most important experiment in African multi-racial education will not seriously impede its development.

The Imperial College of Science and Technology

THE forty-ninth annual report of the Governing Body of the Imperial College of Science and Technology, covering the year ended July 31, 1956 (pp. 101. London: The Imperial College, 1956), refers at some length to the revision of the plan for the expansion of the College. The contract for site clearance and for the foundations of the first part of the mechanical engineering building was placed in May 1956, and the Governing Body hopes that the major obstacles to planning have now been removed and that erection of the buildings for the expanded College will proceed steadily. The inaugural address on the future of the College, delivered by the rector, Dr. R. P. Linstead, in October 1955 is printed in an appendix.

The acquisition of the Princes Gardens site for halls of residence offers a reasonable prospect that both the long-term aim of providing one year of residence for every student and the short-term aim of providing about 500 study-bedrooms may be realized before the end of the coming quinquennium. There has been a satisfactory number of applications for the preliminary one-year course for students who had not specialized in science at school. Full-time men students totalled 2,006 and women students 67, compared with 1,810 and 60, respectively, in 1954–55. Of the total, 538 were undergraduate and 253 postgraduate students of science, and 852 undergraduate and 430 postgraduate students of technology. There were 60 research assistants in science and 55 in technology, and 486 students were persuing research for higher degrees or diplomas.

Linear Programming at the University of Birmingham

LINEAR programming, a method of planning interrelated activities, has developed at an ever-increasing rate since its start about eight years ago. Mathematically, it is a routine for maximizing a given linear combination of variables which are subject to linear inequalities. Since its first application, by George B. Dantzig in 1949, to problems of inter-industry relations, transportation, minimum adequate diets, warehousing, and a hypothetical airlift problem, many economic problems have been found amenable to this technique, and the mathematical interest of the subject has both deepened and widened. One of its most interesting formal applications has been that to J. von Neumann's theory of games. Many geometrical and combinatorial problems are also related to linear programming theory, while in the field of economic applications quadratic and dynamic programming have been added to the earlier discipline. The maturity of the subject has been acknowledged by the Institute of Production Engineering of the University of Birmingham, where a senior executive residential course was organized by the staff tutor in operational research, Mr. R. S. Gander. S. Vajda gave a course of six lectures on theory, and some practical aspects and special cases were dealt with in lectures by M. A. Aczel, K. B. Haley, A. Hoffman, G. Morton, E. Kay and D. G. Prinz. Animated discussions took place after every meeting and practical work periods in the afternoons gave opportunities for testing the understanding of the principles. The course was generally judged a success and it is intended to repeat it in the coming summer.

The Bose Institute, Calcutta

THE thirty-ninth anniversary of the foundation of the Bose Institute was celebrated on November 30, 1956, in the hall of the Bose Institute, when Dr. A. C. Ukil, president of the National Institute of Sciences of India, delivered the eighteenth Acharya Jagadish Chandra Memorial Lecture. Dr. Ukil chose as the subject of his lecture "Frontiers of Biology". The director presented a short report of the activities of the Bose Institute during the past year. The main activities of the Institute, he mentioned, centre around the different aspects of plant life, studied from the biochemical, the physiological, the cytological and the genetical points of view. The objects of such studies range from the simplest of autotrophic cells, the green and blue-green algae, through the fungi, up to the higher plants. Different methods of investigations are employed for the purpose. During the second five-year plan period, the Institute expects to receive Rs. 25 lakhs as recurring grant and Rs. 12·5 lakhs as non-recurring grant. In addition, the Institute will receive this year more than Rs. 2 lakhs as grants-in-aid, including a grant of Rs. 30,000 from the All India Committee for Jute and Oilseeds Research, for the installation of a 20-curie cobalt-60 source of gamma radiation for field irradiation of economic plants.

The use of radioactive isotopes of some common elements as tracers for the study of photosynthesis and plant metabolism is being successfully developed. A Tiselius electrophoresis apparatus recently constructed in the workshop has been put into operation. A number of problems of human pathology are being investigated in co-operation with workers from medical research institutes. A successful method of growing plant gall tumour in synthetic media has been worked out. Investigations of their cellular structure and metabolism promise to be of great importance. Physiological and cytological investigations on the mechanism of mechanical response in plants, in continuation of J. C. Bose's pioneering work, are being successfully continued.

At Mayapuri, Darjeeling, cosmic ray studies in co-operation with the International Geophysical Year (1957–58) have started. The apparatus constructed for the purpose are continuous recording cubical meson telescope and neutron monitors. A large continuously recording pressure ionization chamber will be used in Calcutta.

The Society for Visiting Scientists

THE report presented by the Council to the ninth general meeting of the Society for Visiting Scientists on December 14, 1956, expresses grave concern with the financial position of the Society. Successful dis-

cussion meetings were arranged on such varied subjects as: "Road Traffic: Flow and Control"; "Government Responsibility in Industrial Research"; "Hopes and Aims of the International Geophysical Year"; "Vital Statistics in Psychiatry"; and "The Visit of the Royal Society Delegation to the U.S.S.R.", but lack of funds curtailed the number of receptions. Nevertheless, overseas delegates to the International Congress on the Documentation of Applied Chemistry and to the Faraday Society Discussion on Nucleic Acids were entertained and receptions were arranged for representatives of the Academy of Sciences of the U.S.S.R. visiting Britain under the auspices of the Royal Society and the British Council, for Sir K. S. Krishnan, director of the National Physical Laboratory of India, and for members of the Bureau of the International Council of Scientific Unions. The Overseas Science Students Association had a successful year. Although the Society now has nearly 2,700 members from sixty-four countries, it has been necessary to launch a further appeal for funds. An annual income of £10,000 a year would enable the Society to treble or quadruple the value of its work, which seems to have even greater potentialities at this juncture in international relations. Tribute is paid to the support and co-operation received from the scientific societies.

Physiology and Pathology of the Kidney

In his introduction to "Physiology and Pathology of the Kidney", Prof. Robert Platt directs attention to the wide variety of scientific and medical disciplines brought together in the study of renal disease. This is borne out by the diversity of subjects involved in the sixteen summaries which constitute *British Medical Bulletin*, 13, No. 1, edited by Prof. Clifford Wilson (Pp. xv+74+12 plates. London: British Council, 1957. 20*s*. net). Appropriately, the first essay is on renal function in the new-born (by Prof. R. A. McCance and Dr. E. M. Widdowson), and the last is one on the effects of old age on the kidney by Dr. G. C. Kennedy, who finds that over-nutrition produces lesions in rats which seem to represent premature senility. Three of the essays deal with potassium in relation to the kidney and three with hypertension. Urinary stone formation is discussed by Dr. M. G. McGeown and Prof. G. M. Bull, and the influence of renal disease on bone by Dr. S. W. Stanbury. Perhaps the balance in these reviews seems weighted somewhat in favour of the pathology rather than the physiology of the kidney, but the diseased organ often furnishes a ready-made experiment which can throw light on normal function in man. Dr. H. Harris's article on renal amino-aciduria provides a case in point, for it shows how the three genetically determined disorders included under this title may help to explain tubular absorption in the normal kidney. This collection of reviews, which includes a good deal of hitherto unpublished experimental work, claims to present only a sample of the research now in progress on the kidney. It is to be followed by a similar review on the liver.

Field Studies Council

The annual report of the Field Studies Council for 1955–56 (pp. 68+8 plates. London: Field Studies Council, 1957) should give considerable satisfaction to all who wish to promote interest in field studies. With each of its four Centres recording a student attendance of well over 1,000, the total attendances at all Centres in 1956 showed a considerable increase over the figures for the previous year. Most encouraging is that well over half the total number of visitors to the Centres came from schools; in itself, this is sufficient justification for their existence. Even more use could be made of the Centres, however, and to fill them during the 'off-season' months of May and June, in 1957 the Council is providing courses which should be specially suitable for pupils and teachers in secondary modern schools. To meet the increased pressure at the four existing Centres during the popular periods, a fifth Centre has been opened at Preston Montford in Shropshire. Like the others, it offers a variety of courses in 1957 which should cater for many differing interests in natural history. The problem of finance has again caused great concern to the Council and, to resolve the difficulties so that it may plan solidly for the future, it has been decided to try to raise the sum of £10,000 by loans, subscriptions and donations. Copies of the Council's report and particulars of the appeal may be obtained from Mr. F. H. C. Butler, Ravensmead, Keston, Kent.

Amino-acids in the Growth of Plant Embryos

A. H. G. C. Rijven has investigated the value of glutamine and asparagine as nitrogen sources for the *in vitro* growth of embryos (*Austral. J. Biol. Sci.*, 9, 511; 1956). A comparative study of twelve species was made. Subsequent to his earlier work on *Capsella bursa-pastoris* (L.) Moench., embryos of species from nine families, monocotyledons and dicotyledons, excised from young developing ovules, were grown in a 'sitting drop' culture. For each species, the embryonic growth in length was compared in a control medium, that is, without nitrogen, and in media containing L-glutamine and L-asparagine. In all cases the growth in glutamine was superior. Additional data on *Capsella* are presented which deal with the growth-concentration relationships of glutamine and asparagine. Glutamine increasingly stimulated growth up to 600 mgm./l. Asparagine stimulated growth at 10 mgm./l. but became inhibitory at higher concentrations. The inhibition of growth with asparagine (400 mgm./l.) was also found in *Arabidopsis thaliana* (L.) Heynh. and *Reseda odorata* L. However, at this concentration, asparagine proved stimulating in *Sisymbrium orientale* L., *Cleome viscosa* L., *Medicago tribuloides* Desr. and *M. orbicularis* All., in *Anagallis arvensis* L., *Datura stramonium* L., *Chenopodium album* L. and *Allium cepa* L.

Halidrys siliquosa: Haploid Member of the Fucales

It has long been accepted—admittedly on very scanty evidence—that the Fucales (or Cyclosporeae) are diploid organisms, with no somatic alternation of generations, the brief haploid phase occurring between meiosis in the antheridium and oogonium and the fertilization of the ovum. In 1909 Yamanouchi demonstrated that the first nuclear divisions in the antheridia and oogonia of *Fucus vesiculosus* were meiotic. Since then there have been few further cytological investigations. In a recent study of the cytology of *Halidrys siliquosa*, B. L. Moss and E. Elliot (*Ann. Bot.*, 21, 143; 1957) have made some interesting observations which suggest that the thallus of this brown seaweed is haploid, reduction division taking place immediately after the fertilization of the ovum. They record eight chromosomes in the vegetative cells of the thallus and in the developing antheridial and oogonial cells. No meiosis was

observed in these reproductive cells, whereas what seem to be typical 'bouquet' and diakinesis stages, suggesting meiotic division, have been seen on the germination of the zygote. In cells of the meristoderm, of the apical meristematic tissue, and of the sterile paraphyses, a complement of eight chromosomes has been determined. In the nuclear divisions of the antheridium it has been possible to distinguish the same number of chromosomes as in the somatic cells. Only two nuclear divisions take place during development of the oogonium, and at each of these divisions eight chromosomes have been counted. Typical 'bouquet' and diakinesis stages of a reduction division have been seen on germination of the zygote. The evidence thus suggests that *Halidrys siliquosa* has a haploid thallus, with reduction division occurring immediately following fertilization. It seems likely that these observations will trigger-off a renewal of interest in the cytology of this important group.

The New Atomic Age

A RECENT illustrated booklet, "The New Atomic Age", published by the United Nations Department of Public Information (pp. 40. New York: United Nations; London: H.M. Stationery Office, 1956. 25 cents; 1*s.* 9*d.* 1 Swiss franc), describes in non-technical language the principles of the production of atomic energy and examines the role of nuclear energy in industry, medicine and agriculture. It emphasizes that atomic energy is nothing new, but what is new is man's harnessing of this energy. In one chapter the three categories of reactor—heterogeneous and homogeneous, fast and thermal, and breeder—are briefly described, and in the two succeeding chapters, nuclear radiations and their useful applications, and the expected economic, social and political repercussions of advances made possible by atomic energy, are outlined. The steps which have been taken towards the establishment of the future International Atomic Energy Agency, the initiative for which was first given by the President of the United States in his speech before the United Nations General Assembly on December 8, 1953, are described in the chapter on international co-operation in the atomic field, and it is shown how the various organizations and specialized agencies of the United Nations are already collecting vital information and directing their efforts towards the use of the atom for the benefit of all mankind.

Isotopes of Einsteinium

FIVE new isotopes of the element einsteinium (symbol E, atomic number 99) with mass numbers 248–252 have been identified by members of the Radiation Laboratory and Department of Chemistry, University of California, Berkeley (*Phys. Rev.*, **104**, 1314–1319; 1956). The isotope einsteinium-248 was identified among the products of the deuteron bombardment of californium-249 with 18–22 MeV. deuterons in a 60-in. cyclotron. It decays principally by electron capture with a half-life of 25 ± 5 min. and also by the emission of ($6{\cdot}87 \pm 0{\cdot}02$ MeV.) alpha particles. The four isotopes einsteinium-249 to einsteinium-252 were produced by bombardment of berkelium-2[illegible] with helium ions. A recoil method was used [illegible] separate the bombardment products from the target material, so that the target, which consisted of no more than $1{\cdot}2 \times 10^{-8}$ gm. of berkelium, could be used many times. The nuclear properties of the isotopes, including the half-lives and types of decay, were ascertained and are listed together with many other details of the experimental arrangement and apparatus, and of the measurements taken.

The Manchester Museum

THE report of the Committee of the Manchester Museum for the year ended July 31, 1956 (pp. 24. Manchester: Manchester Museum, The University, 1956), records welcome additional annual grants from both the City Council and the University for the next five years. In view of these, considerable efforts are being made to modernize the Museum and high priority is being given to exhibition work. All departments are endeavouring to increase the storage space available so that the well-organized reserve material could be readily accessible to those engaged in teaching and research. The Lancashire and Cheshire Antiquarian Fund has been used for providing two important lectures and for purchasing several interesting additions to the collections of British bronze implements as well as a sixth-century Anglo-Saxon urn. Progressive work is recorded from all departments and an impressive list of publications by members of the staff is included.

The United States National Museum

THE annual report of the United States National Museum for the year ended June 30, 1956 (pp. ix + 105+10 plates. Washington, D.C.: Government Printing Office, 1956), states that a contract between the Government and an architect for the design of a building for the Museum of History and Technology was signed in March 1956. The schedule of requirements for the building was based on several years study by the Smithsonian staff. It is gratifying to note that a sum of no less than 36 million dollars has been allocated for the building. The programme of modernizing the exhibition halls was continued during the year and contracts signed for a second American Indian Hall and a Health Hall. During the year the new Bird Hall and the east side of the North American Mammal Hall were completed. The curatorial part of the report records the installation of many new exhibits, and a list of publications by the staff is supplemented by a description of the investigations and researches carried out during the year.

The Clean Air Act, 1956

UNDER the title "The Clean Air Act, 1956: a Guide for Industrialists", the Federation of British Industries has published a useful handbook (pp. vi+10. London: Federation of British Industries, 1956. 2*s.*) explaining the main points of the Act and describing the provisions dealing with dark smoke, smoke from furnaces, grit and dust from furnaces, smoke control areas and smoke nuisances. Provisions dealing with scheduled processes under the Alkali Act and other special cases are summarized, as well as those relating to research and publicity and to the penalties which may be incurred under the Act.

Research in Orthoptera

THE recent increase in the number of workers engaged in locust research and much more widespread use of locusts as biological material have led to the risk of overlapping of effort and duplication of research. In the hope of reducing this risk and to facilitate communication between workers in related

fields of Orthopteroid research, the Anti-Locust Research Centre has issued a questionnaire to all persons known to be engaged in such work asking them for information on their research programmes. The data gathered from this survey will be circulated in the form of an indexed list of workers and their current problems, and distributed to all interested institutions and persons. Any workers who wish to be included in the list, or to receive it when published, are asked to write to the Director, Anti-Locust Research Centre, 1 Princes Gate, London, S.W.7.

Zoological Nomenclature

The International Commission on Zoological Nomenclature gives notice that as from July 25, 1957, it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified. Full details were published on January 25 in the *Bulletin of Zoological Nomenclature* (13, Part 1): (1) *bullata* Müller (O.F.), 1776 (*Akera*), validation (Cl. Gastropoda); (2) *bengalensis* Daudin, [1802] (*Tupinambis*) and *salvator* Laurenti, 1768 (*Stellio*), validation (Cl. Reptilia); (3) *Bithys* and *Chrysophanus* Hübner, 1818 (Neotropical Theclids), suppression (Cl. Insecta, Order Lepidoptera); (4) *Cephalomutilla* André (1908), designation of type species (Cl. Insecta, Order Hymenoptera); (5) *Aurelia* Lamarck, 1816, validation (Cl. Scyphozoa); (6) *Indiana* Matthew, 1902, designation of type species (Cl. Crustacea, Order Ostracoda). Comments should be sent as soon as possible and in duplicate to Francis Hemming, Secretary to the Commission, 28 Park Village East, Regent's Park, London, N.W.1.

"The X-ray Powder Data File"

Dr. G. W. Brindley requests the authors of papers describing investigations in which X-ray powder measurements were made, but omitting the actual X-ray data, to submit these data to him as Editor of the Joint Committee on Chemical Analysis by Powder Diffraction Methods, for possible inclusion in the "X-ray Powder Data File" published by the American Society for Testing Materials. The data should include accurate lists of '*d*' values and intensities of reflexions. Other items of information of value for the data file are: *hkl* indices and lattice parameters if known, radiation used, type of X-ray recording employed, method of estimating intensities (visual, photometric, Geiger-counter), plus any relevant information concerning the nature and preparation of specimens studied. The address of Dr. Brindley is: The Editor, "X-ray Powder Data File", College of Mineral Industries, Pennsylvania State University.

Life Insurance Medical Research Fund of Australia and New Zealand

The Life Insurance Medical Research Fund of Australia and New Zealand has been established by the Life Offices' Association for Australasia to promote and assist scientific and medical research. For the present it is intended to use the resources of the Fund to stimulate and support research in the field of cardiovascular function and disease.

Grants in aid will be given to non-profit making institutions with basic facilities and qualified personnel for medical research to be used in support of a specific programme of investigation under the direction of a particular investigator. Both fundamental and clinical research projects will be supported. Grants will usually range from £1,000 to £3,000 per annum, to cover all the financial requirements of a programme.

Research Fellowships will be open to medical graduates or those with equivalent scientific training for full-time research on fundamental problems broadly related to cardiovascular function and disease or clinical investigations in these fields. Fellowships taken up in Australia and New Zealand will be granted for one year in the first instance, for work in an approved institution, under the supervision of a qualified investigator. Awards will range from £1,800 to £2,000 for the term of one year. Travelling Fellowships will be granted for a period of two years abroad, followed by a third year in an approved institution in Australia or New Zealand. Awards will range from £2,000 to £2,250 per annum, and in addition approved travelling expenses will be allowed.

Further information and application forms (to be returned before July 1) may be obtained from Dr. J. H. Halliday, Medical Director, Life Insurance Medical Research Fund of Australia and New Zealand, 87 Pitt Street, Sydney, New South Wales.

International Symposium on Curare

A symposium on the problem of curare and curarizing substances will take place in Brazil during August 5–17, organized by Unesco, the Conselho Nacional de Pesquisas (National Council of Research, Brazil), the Academia Brasilera de Ciencias and the University of Brazil. During August 5–10 meetings will be held at the University of Brazil in Rio de Janeiro on (*a*) the ethnographic problems concerning South American curares; (*b*) the botanical origin of the active principles of curares; (*c*) the chemistry of the curarizing alkaloids; (*d*) synthetic curares; (*e*) physiology of neuromuscular transmission and mechanism of curarization; (*f*) pharmacological properties; (*g*) clinical applications of curares. During August 11–17 a visit to Manaus (Instituto Nacional de Pesquisas de Amazonia) and to Belem (Instituto Agronomico do Norte) will be arranged. The official languages of the symposium are Portuguese, English, French and Spanish, and the proceedings will be published by Unesco and the Paternò Foundation of the Istituto Superiore di Sanità, Rome. Correspondence should be addressed either to Prof. C. Chagas, Instituto de Biofisica, Universidade do Brasil, 458 Avenida Pasteur, Rio de Janeiro, or to Prof. Daniel Bovet, Istituto Superiore di Sanità, 299 Viale Regina Elena, Rome, or to Prof. P. B. Carneiro, Délégation du Brésil, Unesco, 19 Av. Kléber, Paris 16.

Nutrition of Parasites

The Institute of Biology is arranging a whole-day symposium on "The Nutrition of Parasites", which will be held in the rooms of the Royal Entomological Society, 41 Queen's Gate, London, S.W.7, on April 12. The morning session will deal with the nutrition of parasitic protozoa and will include papers on amœbæ, trichomonads, trypanosomes, plasmodia and the ciliates of ruminants. In the afternoon the nutrition of helminths is to be considered: papers will deal with the *in vitro* and *in vivo* approaches to helminth nutrition, the feeding habits of trematodes and the nutrition of nematodes. The symposium will be open to all interested persons. Further particulars may be obtained from the General Secretary, Institute of Biology, 41 Queen's Gate, London, S.W.7.

Announcements

Dr. Gerhard Herzberg, director of the Division of Pure Physics, National Research Council of Canada, has been elected an honorary member of the Indian Physical Society. He is the first person outside India to be thus honoured. During his current lecture tour in India, undertaken at the invitation of the Indian Science Congress, Dr. Herzberg was also presented with the Joy Kissen Mookerjee Gold Medal for 1954, awarded by the Indian Association for the Cultivation of Science.

The award of the Rennie Memorial Medal for 1956 has been made to Dr. P. R. Jefferies, senior lecturer in chemistry at the University of Western Australia, for his researches on terpenes and the stereochemistry of cyclohexane derivatives. This annual award is administered by the Royal Australian Chemical Institute and is made to a member under thirty years of age for the best contribution to the development of chemical science in Australia.

The Bourke Lectures of the Faraday Society will be given by Prof. A. J. Rutgers, of the University of Ghent, who will speak on "Electrokinetic Researches". The Lectures will be delivered in the Department of Chemistry, University of Bristol, on May 8 at 5.30 p.m.; of the University of Reading on May 9 at 4.30 p.m.; and of King's College, Newcastle upon Tyne, on May 10 at 5 p.m. Admission in each case is free and without ticket.

The 361st meeting of the Biochemical Society will be a joint meeting with the Société Belge de Biochimie–Belgische Vereniging voor Biochemie, and will be held in the Department of Biochemistry of the University of Oxford on Friday and Saturday, April 12 and 13, starting at 11 a.m. on the Friday.

The following appointments in the University of Birmingham have been announced: Dr. J. C. Robb, at present lecturer in chemistry, to be professor of physical chemistry; Dr. G. F. Alfrey, to be lecturer in electron physics; S. V. Hayes, to be lecturer in mechanical engineering; E. H. L. Harries, to be lecturer in physiology.

A sectional meeting of the World Power Conference will be held in Belgrade during June 5–11, after which there will be a series of study tours. The general programme and membership application forms are available from the British National Committee, World Power Conference, 201–2 Grand Buildings, Trafalgar Square, London, W.C.2.

The Fourth International Congress of Nutrition, to be held under the auspices of the International Union of Nutritional Sciences, is to take place in Paris during July 26–August 1. For information about the Congress, early application should be made to Prof. E. Terroine, 4ème Congrès International de Nutrition, Centre National de Coordination des Études et Recherches sur la Nutrition et l'Alimentation, 71 Boulevard Péreire, Paris, 17e, as enrolments should be in his hands early in April. Information about the International Union of Nutritional Sciences can be obtained from the Secretary-General, Dr. Leslie J. Harris, Dunn Nutritional Laboratory, Milton Road, Cambridge.

The British Glaciological Society has recently set up a sub-committee to encourage and advise on glaciological research. This sub-committee has already advised some ten expeditions visiting Norway, Kashmir, Iceland, Africa and Antarctica, on their glaciological programmes, and is preparing a series of duplicated Technical Notes on the kinds of measurements that it is desirable to make on glaciers, and on the techniques involved. Inquiries from persons organizing scientific expeditions to glacierized regions should be addressed to the Secretary, British Glaciological Society, c/o Scott Polar Research Institute, Lensfield Road, Cambridge, England.

A Symposium on "Recent Developments in Research Methods and Instrumentation", sponsored by the Washington sections of the American Chemical Society, the Instrument Society of America, the Society of American Bacteriologists, the American Association of Clinical Chemists, the Society for Experimental Biology and Medicine and the group on medical electronics of the Institute of Radio Engineers, is to be held in conjunction with the seventh Annual Research Equipment Exhibit, during May 13–15, at the Clinical Center Auditorium, Public Health Service, National Institutes of Health, Bethesda, Maryland. The symposium will include sections on the processing and computation of biological data, automation in the laboratory, nuclear magnetic and paramagnetic resonance, tissue culture and its significance in bacteriology and virology, and on electron microscopy. Further details can be obtained from the Department of Health, Education and Welfare, Public Health Services, National Institutes of Health, Bethesda 14, Maryland.

The fifth Midlands Conference of the British Institute of Management is to be held at Droitwich during April 5–7. The programme has been planned in conjunction with the Institution of Production Engineers; its theme will be "Meeting To-morrow's Problems". The conference is organized by the British Institute of Management and the Institute of Industrial Administration with the support of regional organizations of the Federation of British Industries and the National Union of Manufacturers. At each of the working sessions the emphasis will be on an exchange of information between top managers in the Midlands. Speakers will summarize papers previously circulated to delegates and discussion from the floor will occupy the greater part of the meeting. Guest speaker at the closing dinner on April 6 will be Mr. Aidan Crawley. Further information can be obtained from the Conference Secretary, British Institute of Management, 8 Hill Street, London, W.1.

The essay subjects for this year's *Endeavour* Prizes of the British Association for the Advancement of Science will be as follows: the International Geophysical Year; science fiction; Irish contributions to science; atmospheric pollution; chemistry and the conquest of disease; particles in plant or animal cells. Essays, which must be in English and should not exceed four thousand words in length, must be sent in before June 1. Competitors must be less than twenty-five years of age. Prizes will be 50, 25 and 15 guineas, respectively, with two special awards of 5 guineas to those less than eighteen years old. Full particulars can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

The general headquarters of the Institution of Electronics has moved to a new address at 78 Shaw Road, Rochdale, Lancashire. The former general headquarters, at 20 Buckingham Street, Strand, London, W.C.2, is to be retained as the headquarters of the London Division of the Institution.

EDMOND HALLEY (1656–1742)

TO mark the tercentenary of the birth of Halley in 1656, the British Astronomical Association has published a "Memoir"*, prepared by Mr. C. A. Ronan, who is director of the Historical Section of the Association. The "Memoir" includes a reproduction of a portrait of Halley by Thomas Murray, in the possession of the Royal Society, a photograph of Halley's transit instrument, supplied by the Royal Greenwich Observatory, and a drawing of the 8-ft. mural quadrant made for Halley by George Graham. Dr. Angus Armitage, lecturer in the Department of the History and Philosophy of Science at University College, London, contributes an introductory paper on "Halley's Astronomical Heritage".

Dr. Armitage provides an outline of the position which astronomical knowledge and speculation had reached about the time when Halley was entering upon his labours. It is remarkable that, in spite of the fact that seventeenth-century Christendom was racked by strife and dissension, nevertheless western Europe then saw the rise of scientific societies "pledged to promote natural knowledge by concerted investigation and free discussion". Among the developments in astronomical thought, the most momentous for the future was the conception of the universe extending indefinitely in all directions, populated with suns and possibly planetary systems which were, perhaps, inhabited. In his later years Halley supported this view and opposed the view that, if the entire universe was so constituted, the whole surface of the celestial sphere would appear luminous. While Halley thus showed his interest in ultimate cosmological speculations, he was largely concerned with problems of practical and geometrical astronomy.

This subject is well developed by Dr. Armitage and provides an excellent introduction to the two succeeding chapters; in Dr. Armitage's own words: "He (Halley) lived at a crucial and formative period in the growth of the science when energies that had been slowly building themselves up for centuries were almost simultaneously released, enhancing and intensifying one another's effects".

Mr. Ronan's first paper, "Edmond Halley—the Man and his Work", gives a short account of Halley's earlier years, and his versatility is shown from the fact that after leaving Oxford in 1676 he communicated a learned paper to the Royal Society when he was only twenty, in which he discussed the problem of finding the eccentricities and aphelia of the planets, finally abolishing the notion of a fixed centre about which uniform motion was supposed to take place. While much of this chapter is 'ancient history' to many, nevertheless there is a very great advantage in having it presented in such an interesting form. Perhaps more interesting still is the last chapter, "The Effect of Halley's Astronomical Work on Later Astronomy", which points out that many histories of astronomy are content to mention Halley's work on comets and his efforts which resulted in the publication of Newton's "Principia". Mr. Ronan directs attention to various other sides of Halley's work, such as the discovery that stars shift their position in space, a phenomenon later known as 'proper motion'; his pioneer work on geomagnetism and geophysics and also in meteorology: the stimulus that he gave by his early efforts to determine the solar parallax; his work in cataloguing southern stars, laying the foundations for his successors in this field; and his interest in novæ and variable stars. As the author comments (p. 33): "If he himself had made no discoveries and had not persuaded Newton to pursue his work on universal gravitation, Halley would still be remembered for the effect he had on subsequent research. Adding then his own discoveries and his efforts on the 'Principia' we can see clearly that this great astronomer played a vital part in furthering astronomical science not only in his own day but also in the years that followed".

* Memoirs of the British Astronomical Association. Vol. 37, No. 3: Edmond Halley, 1656–1742—Papers to Commemorate the Tercentenary of his Birth. Pp. 39+2 plates. (Hounslow West, Mddx.: British Astronomical Association, 1956.) 5s.

HYDROMEDUSAE OF THE SOUTHERN HEMISPHERE

IN a recently published report*, Dr. Kramp deals with the systematics and zoogeography of eighty-five species of Hydromedusae chiefly from the earlier voyages of the "Discovery" Investigations, and although the material is mainly from the Southern Ocean, it also includes medusae collected in the North and Central Atlantic and in the Indian Ocean. Let it be said immediately that this is the most important contribution that has ever appeared on the hydromedusan fauna of the southern hemisphere.

This report fills many gaps in our knowledge of the distribution of medusae, and suspicions (which have been growing for some time) are confirmed that many species, which were once thought to be restricted to the North Atlantic, are now shown to have an extensive distribution. Many, with names made familiar to us through F. S. Russell's "Medusae of the British Isles", are now recorded from the South Atlantic and elsewhere. The great contribution which this report makes to the zoogeography of medusae can best be appreciated by consulting the sixteen excellent distribution maps.

Seven new species are described, one, *Russellia mirabilis*, being so remarkable as to require a new family, the Russellidae, to take it. It is suggested that the genus has affinities with the Calycopsidae and the Pandeidae rather than with the Bougainvillidae to which it has a superficial resemblance.

Dr. Kramp has made the interesting discovery of stolons and stalked hydranths carrying medusa buds on the stomach of the medusa *Bougainvillia platy-*

* "Hydromedusae from the Discovery Collections". By P. L. Kramp. (Discovery Rep., Vol. 29.) Pp. 128+7 plates+19 text figs. (Cambridge: At the University Press, 1957.) 63s. net.

gaster Haeckel. These stolons and polyps issue from the corners of the stomach and are regarded by him as a means of asexual propagation. This implies that the medusa is no longer restricted to coastal waters by the need for a benthic hydroid phase and can range farther afield; in fact, as the distribution map shows, it is in process of becoming an oceanic species.

The fragile Narcomedusae are not easy to investigate in expedition material because of the difficulty of obtaining satisfactorily preserved specimens. Nevertheless, much progress has been made by concentrating on hitherto little-used characters, and by careful work Dr. Kramp has gone a long way towards a revision of the genera *Pegantha*, *Solmissus* and *Cunina*; his own comment is that a reliable revision requires the study of living specimens.

The life-histories of most Narcomedusae still await elucidation, but their larvæ are known to develop attached to other medusae. Here four kinds, two of them tentatively assigned to *Pegantha triloba* and to *Cunina peregrina*, are recognized.

In all narcomedusan larvæ hitherto studied "the larvæ propagate by budding, but the primary individual, as well as all the others, develops into a medusa, so that (as emphasized by Brooks) there is no true alternation of generations". In the examples studied by Dr. Kramp, however, the tentacles of the primary polyp are dimorphic and different from those of the medusa buds which are "of equal size and structure, and the primary individual remains in a polypoid stage". If the latter statement is true—and we have no reason for doubting it from the evidence—then the text-book concept, that all the Narcomedusae have a direct development, will have *to be considerably amended*.

In the zoogeographical remarks the author indicates that "the dominant factor in the distribution of medusae is the temperature of the water, and for holopelagic species it is often the only factor of importance, although indeed some of these medusae can tolerate a wide range of temperature". He groups the species into very useful distributional tables according to whether they are neritic, epipelagic or bathypelagic, and it is possible to tell at a glance whether a species has been found in a particular area. These distributional regions are based mainly on Ekman's divisions and have been modified to take account of oceanic areas. This is followed by a detailed discussion of the different species in the ecological groups noted above and it is stated that "very few epipelagic species of medusae are common to antarctic and antiboreal waters, the Antarctic convergence evidently constituting an effective barrier to the distribution of these animals". Only one neritic leptoline medusa (*Staurophora mertensi*) is bipolar. North of the Antarctic convergence is the area embracing the Falkland Islands, which has a number of characteristic neritic Leptolina such as *Proboscidactyla mutabilis*, *Laodicea pulchra* and *Phialella falklandica*. Species like *Zanclonia weldoni*, *Calycopsis borchgrevinki* and *Ptychogena antarctica*, which are well-known Antarctic species, are shown to have a circumpolar distribution.

These brief comments cannot do more than indicate that this authoritative report is a very interesting one containing a wealth of information for the planktologist. Its publication in February 1957 coincided with Dr. Kramp's retirement from his post as keeper of invertebrates at the Zoological Museum, Copenhagen. It is hoped that he will continue the fruitful researches that he has carried out in this field for nearly fifty years. He has done more than anyone else, since Haeckel and Mayer, to place the identification of medusae on a sound basis, and, to use his concluding remark in this report, "this is a necessary condition to every discussion of distributional questions".

W. J. Rees

PHYSIOLOGY OF EXSHEATHMENT IN NEMATODES AND ITS RELATION TO PARASITISM

By Prof. W. P. ROGERS
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AND
R. I. SOMMERVILLE
Division of Animal Health and Production, Commonwealth Scientific and Industrial Research Organization, McMaster Laboratory, Sydney

In the life-cycle of many nematodes the egg hatches to produce the first 'larval' stage, which then moults to give the second stage. Moulting is repeated at the end of the third and fourth stage to give the adult. However, in some nematodes, such as *Trichostrongylus axei* and related species which are discussed here, the complete moulting of the second stage is delayed so that the third stage is enclosed in two cuticles, the outer usually called the sheath. After the sheathed form is eaten by a sheep, the sheath fractures[1] about 20μ from the anterior end. This exsheathment is the first obvious change which takes place when the nematode enters the parasitic phase of the life-cycle.

We wish to advance the hypothesis that moulting in nematodes is controlled by endocrine systems and that, in parasitic species, the delayed exsheathment of the second stage is due to the suspension of the normal endocrine mechanism. We suggest that factors from the host are necessary to stimulate the processes which complete moulting.

Preliminary work was concerned with the change which occurs when larvæ of *T. axei* become parasitic. Results suggested that factors in rumen fluid stimulated the process which caused exsheathment. It seemed that two separate mechanisms may have been involved: (1) the stimulation by the host; and

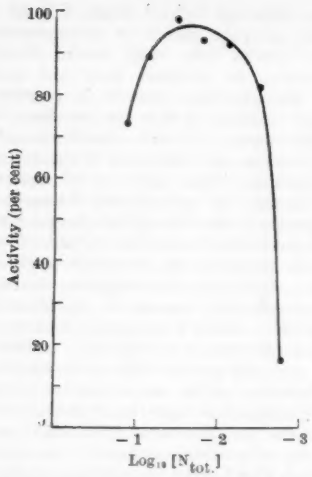

Fig. 1. Activity of rumen fluid as a function of total nitrogen concentration

(2) the secretion by the parasite of substances that caused exsheathment.

Third-stage larvæ, when placed in a dialysis sac in a rumen fistula, usually exsheathed within two hours. This result could be reproduced in rumen fluid *in vitro* at 38° C.; but results were variable. The exsheathing activity of rumen fluid was reduced by filtering, centrifuging, aerating, boiling, dialysis and freeze-drying. Activity could usually be restored by adding a reducing agent, sodium dithionite, 1 mgm./ml. The reducing agent alone had low activity (less than 15 per cent). Larvæ which had been killed by heating at 60° for 10 min. did not exsheath.

The relation between activity and total nitrogen (mgm./ml.) in dialysable material from rumen fluid is shown in Fig. 1. The dialysable material was freeze-dried and then dissolved at different concentrations in *M*/100 phosphate buffer at *p*H 6·8. Sodium dithionite, 1 mgm./ml., and larvæ were added and the tubes sealed with paraffin. Activity was assessed as the proportion of 50 larvæ which had exsheathed after 4 hr. at 38°. At high concentrations the larvæ were shrivelled and few exsheathed. This was probably due to high salt concentration, because similar effects were produced at low concentrations of the freeze-dried dialysable material by adding sodium chloride, 50 mgm./ml.

Optimal hydrogen ion concentrations for exsheathment of three species in rumen fluid were as follows: *Haemonchus contortus*, *p*H 6·5 to 7·5; *T. axei*, *p*H 5 to 6; *T. colubriformis*, below *p*H 4. These results may give an explanation for the observation[2] that species which exsheath in the rumen live as adults in the abomasum, whereas those which exsheath in the more acid abomasum live as adults in the small intestine.

Rate of exsheathment was affected by temperature; at 29° no exsheathment occurred in 200 min., but in the same time 50 per cent exsheathed at 35°, and 90 per cent at 40°.

The effect of sodium dithionite on the activity of rumen fluid suggested that activation might be affected by oxidation-reduction potentials. This was tested by incubating larvæ for 2 hr. at 38° in cultures of *Escherichia coli*, which had been shown by Poynter[3] to cause exsheathment. Activity increased from about 10 to 90 per cent as the potential of the *E. coli* culture fell from about + 600 mV. to − 400 mV.

Exposure of third-stage larvæ to active rumen fluid for 10 min. followed by washing and incubation in water for 2 hr. at 38° induced exsheathment, that is, processes which led to exsheathment continued in the absence of substances from the host. At least two explanations are possible: either the rumen fluid had a direct effect upon the sheath which continued after exposure of the larvæ, or the rumen fluid stimulated the larvæ to produce an 'exsheathing fluid' which remained active in the absence of rumen fluid. Rumen fluid was found to be without effect on sheaths in the absence of larvæ, but water in which larvæ had been 'triggered' to exsheath by rumen fluid caused a swelling and splitting of the sheaths as was found in normal exsheathment. We conclude that the larvæ, after stimulation in the rumen fluid, produced an exsheathing fluid which was released into the water.

Larvæ from which the sheaths have been removed by sodium hypochlorite[1] produced exsheathing fluid when stimulated by rumen fluid, that is, the exsheathing fluid came entirely from within the larvæ.

The site of formation or secretion of exsheathing fluid was sought by ligaturing larvæ. Ligatures of fine nylon in front of the posterior end of the œsophagus prevented exsheathment, whereas ligatures behind the œsophagus were without effect. Moreover, exsheathment was not prevented by severing the larva immediately posterior to the œsophagus. This suggests that cells near the base of the œsophagus were concerned in the production of exsheathing fluid.

The process of exsheathment has been described by Lapage[1]. The sheath swelled and split at the point of fracture, and complete separation of the cap from the sheath was effected by movement of the larva within the sheath.

In our experiments, activity of exsheathing fluid, obtained by exsheathing *H. contortus* larvæ in dialysable material from the rumen, was assessed at 38° using sheaths which had been dissected from larvæ. Actual separation of the cap could not occur, but the swelling and splitting of the cuticle were observed.

Below *p*H 3·9 exsheathing fluid was inactive, but activity was restored when the solutions were made

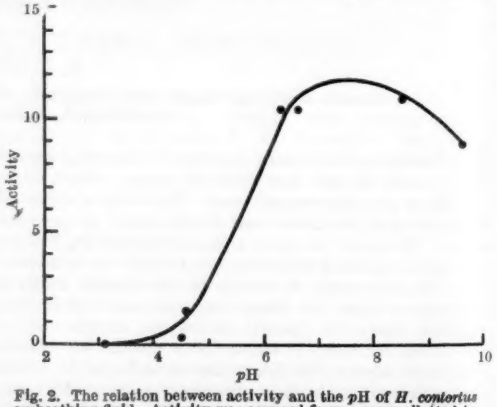

Fig. 2. The relation between activity and the *p*H of *H. contortus* exsheathing fluid. Activity was assessed from a score allotted to each of the three stages into which the processes of swelling and splitting of the cuticle were arbitrarily divided

neutral. The relation between *p*H and activity is shown in Fig. 2.

Exsheathing fluid was inactivated when heated to 65°, and after dialysis. The dialysable fraction was freeze-dried and taken up in a small volume of water to increase concentration. This material was inactive, but restored activity to the solution in the dialysis sac. It seemed, therefore, that the action of the exsheathing fluid involved a co-factor of low molecular weight.

Active exsheathing fluid prepared from *T. axei* larvæ had no effect on sheaths dissected from *T. colubriformis* or *H. contortus*, but exsheathing fluid from the latter affected sheaths of both *T. axei* and *T. colubriformis*.

Summary and Conclusions

(1) The exsheathment which accompanied the change from the free-living to the parasitic form involved stimulation by factors in rumen fluid which appeared to be more effective at low oxidation-reduction potentials.

(2) The effect of hydrogen ion concentration on stimulation by rumen fluid may determine the distribution of adult *H. contortus*, *T. axei* and *T. colubriformis* in the alimentary tract of the sheep.

(3) As a result of stimulation exsheathing fluid was secreted, probably by cells at the base of the œsophagus.

(4) The exsheathing fluid was heat-labile and contained a dialysable co-factor.

It is possible that the process of moulting in nematodes generally is started by secretions which lead to the formation of a new cuticle during lethargus. Exsheathment may involve a second mechanism of the type described here, but in free-living forms exsheathment may be stimulated by intrinsic factors. Adaptations to suspend exsheathment, except as a response to extrinsic factors provided by the host, may have been important in the development of parasitism in some nematodes.

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CHEMICAL ANALYSIS BY DIFFUSE REFLEXION SPECTROPHOTOMETRY

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WHILE widespread use is made of absorption spectrophotometry for the quantitative analysis of transparent media, these methods are inapplicable to diffusing media. There exists a need, particularly in biological problems, for a method dealing with diffusing media containing absorbing substances, corresponding to that based on Beer's law for transparent media.

The transmission and reflexion properties of a uniformly dispersed plane-parallel diffusing medium depend mainly on the ratio α/σ of the absorption and scattering coefficients within the medium, and on the optical thickness of the medium. If the medium is semi-infinite, or so thick that its diffuse transmission is negligible, the latter dependence disappears, and the problem is greatly simplified.

Fig. 1 shows the total (diffuse + specular) reflectance of a semi-infinite isotropically scattering medium as a function of α/σ; the matrix in which the scattering particles are suspended has a refractive index of 1·333, the medium being in contact with a cover glass of refractive index 1·523, while the incident radiation falls normally on the surface. Similar curves for matrices of other refractive indices can be plotted from data which I have published[1].

The shapes of such curves depend on the polar scattering diagram for a single particle, which will usually be unknown, but the variations are small enough to be neglected for biological work. It is interesting to note that, over the reflectance-range 0·2–0·7, the curve of reflectance R against $\log \alpha/\sigma$ is almost linear.

Used with a curve of this type, measured reflectances yield α/σ. If, because of the existence of absorption bands, α possesses spectral maxima, the spectral reflectance will exhibit corresponding minima; thus the spectral reflectance curve leads readily to a plot of the spectral variation of α/σ.

If we require the concentration of a component A which makes a contribution α_a to the absorption coefficient, the remainder α_b of the absorption

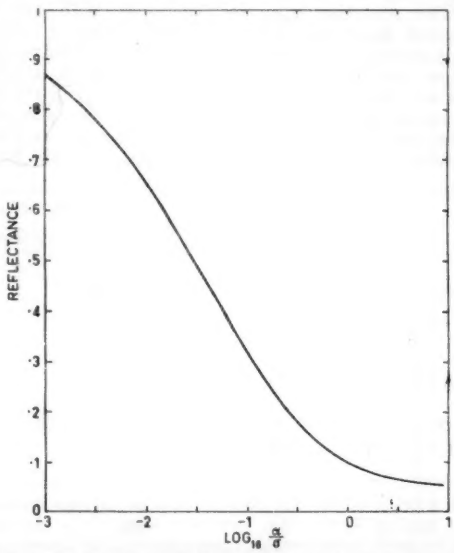


Fig. 1. Total reflectance R of a semi-infinite isotropically scattering diffusing medium, N(matrix) = 1·333, in contact with a cover glass N = 1·523, as a function of $\log_{10} \alpha/\sigma$

coefficient, which is due to other absorbing constituents, may be regarded as background. The spectral reflectance curve due to the background absorption alone can be derived from an iteration process. A first estimate is made by interpolating graphically between wave-lengths at which the values of α_s are known to be small. This leads to estimates of ΔR_0, the decrease in reflectance due to constituent A at the centre of the band, and of W, the half-width of the absorption band, if this is not already known. From the usual form of the spectral absorption coefficient in a band,

$$\alpha_\lambda(\lambda) = \frac{kg}{1 + (\Delta\lambda/W)^2}$$

where k is the concentration, g a physical constant of the band and $\Delta\lambda$ the wave-length interval from the centre of the band, it is easy to predict ΔR, the decrease in reflectance within the band, and to show that, when ΔR_0 is small,

$$\frac{\Delta R}{\Delta R_0} = \frac{1}{1 + (\Delta\lambda/W)^2}$$

It is then a matter of checking to ensure that the difference between the interpolated background and the observed reflectance curve conforms to this relation, and otherwise to draw an improved background curve and repeat the process.

If there are a number of overlapping absorption bands, the analysis is rather longer, but nevertheless straightforward. Fig. 2 shows the spectral reflectance of a suspension of *Aerobacter aerogenes* containing cytochromes, as measured on a recording spectrophotometer. Various strong and weak bands may be noted, centred on wave-lengths 426, 529, 560, 598 and 633 mμ. The final background is shown, and the values of ΔR_0 due to each band may be obtained to an accuracy varying from about 2 per cent for the 426 mμ band to about 15 per cent for the 598 mμ band. Fig. 1 then leads to the various values of α_s/σ for the centre of these bands.

The quantity α_s/σ is the most that can be derived from this analysis; since σ usually varies only slowly with wave-length, relative concentrations of components having absorption bands in not too distant spectral regions can be readily found, though absolute calibrations require at least one absolute chemical analysis (as is also the case for conventional transmission spectrophotometry using Beer's law).

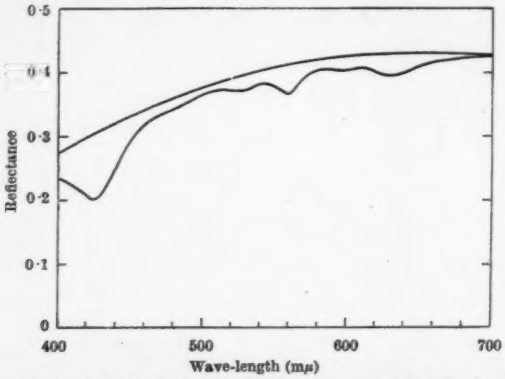
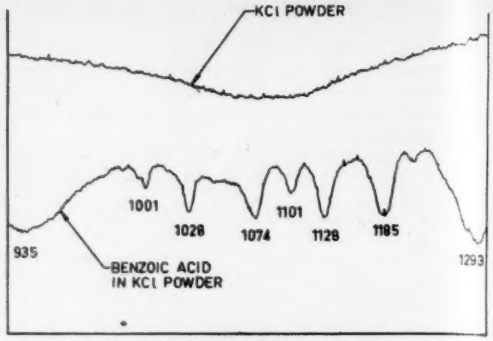


Fig. 2. Spectral reflectance of *Aerobacter aerogenes* (lower curve), and the background (upper curve) obtained by eliminating the absorption bands



Infra-red diffuse reflexion spectrum of benzoic acid (frequencies in cm.$^{-1}$)

Fig. 3. Infra-red diffuse reflectance of a powdered mixture of benzoic acid with potassium chloride. Frequencies (cm.$^{-1}$) refer to the reflectance minima. The upper curve shows the 100 per cent reflectance from potassium chloride powder alone

Relative concentrations of one substance in different media are also readily obtained, provided the value of σ remains constant. Fairly simple methods are also available for dealing with such problems when σ is variable from sample to sample. Suppose, for example, that in two samples identified by subscripts 1 and 2, $\alpha_{s1}/\sigma_1 = X$, $\alpha_{s2}/\sigma_2 = Y$, which can both be found from measurement. Now make an intimate mixture of equal parts by volume of the two samples, when the resulting absorption and scattering coefficients become $\frac{1}{2}(\alpha_{s1} + \alpha_{s2})$, $\frac{1}{2}(\sigma_1 + \sigma_2)$ respectively. The reflectance then leads to a corresponding result:

$$\frac{\alpha_{s1} + \alpha_{s2}}{\sigma_1 + \sigma_2} = Z$$

Then

$$\frac{\alpha_{s1}}{\alpha_{s2}} = \frac{Z/Y - 1}{1 - Z/X}$$

Although this method is most readily applicable in the visible part of the spectrum, and to some extent in the ultra-violet, because of the availability of suitable spectrophotometers, it is also possible to undertake spectral reflectance measurements in infra-red regions. Fig. 3 shows a portion of a diffuse reflectance spectrum of powdered benzoic acid, mixed in suitable proportions with powdered potassium chloride, obtained by using an experimental mock-up diffuse reflectance attachment in conjunction with a Perkin–Elmer infra-red spectrometer. It has been found necessary to irradiate the sample with undispersed radiation using a wide-aperture mirror condenser, and this necessitates rotating the sample and cooling with an air-blower to limit the rise of temperature; but there do not appear to be fundamental reasons why diffuse reflectance spectra should not be obtained, if required, in these spectral regions.

The main limitation to the use of diffuse reflexion spectrophotometry for chemical analysis is the necessity to ensure thorough, or at least reproducible, dispersion; for the relation between R and α/σ varies according to the degree of aggregation of the particles.

A fuller account of this work will be published in the *Australian Journal of Experimental Biology and Medical Science*.

[1] Giovanelli, R. G., *Optica Acta*, **2**, 153 (1955).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Conjectured Electrolytic Enrichment of Tin Isotopes

IT is, of course, a matter of history that a considerable enrichment of heavy water was found in long-used commercial electrolytic cells.

It occurred to me some years ago that a corresponding enrichment of tin isotopes may take place in the formidably large industrial plants used for the continuous electrolytic manufacture of tinplate. To take but one example, the Ebbw Vale tinplate works of Richard Thomas and Baldwins continuously employs a volume of tin electrolyte from which may be plated, in a period of 1½ years, some 550 tons of tin. The current density in the bath is of the order 200 amp./sq. ft., the current passed being some 50,000 amp. Over the long time period this corresponds to the formidable figure of some 250 million amp. hours passing through about 30,000 litres of solution containing, say, 30 gm. metallic tin per litre.

Although, of course, the hydrogen–deuterium mass ratio is exceptional, yet owing to the large spread of isotopes in tin, the ratio position is much better than one might expect for masses in the region of 120. The isotope abundance percentage figures in normal tin (Aston) are as follows:

112	114	115	116	117	118	119	120	122	124
(1·1)	(0·8)	(0·4)	(15·5)	(9·1)	(22·5)	(9·8)	(28·5)	(5·5)	(6·8)

There is then a mass spread of some 10 per cent and furthermore the two extreme isotopes, namely, 124 and 112, are present in the ratio of about 6 : 1, which is a good ratio for measurement. Arguing by analogy from the hydrogen–deuterium electrolysis, it might well be expected that any tin extracted from such a long-run bath might exhibit an appreciably altered isotope distribution. One would anticipate a shift in concentrations favouring an increase in the heavier isotopes and a decrease in the lighter. In particular, one would seek for and expect that the ratio of tin-124 to tin-112 would be bigger than the value 6 : 1 of normal tin.

A sample of electrolyte from such a long-used tin plating bath has kindly been supplied by Richard Thomas and Baldwins through the good offices of Dr. W. E. Hoare of the Tin Research Institute, Fraser Road, Greenford, Middlesex. Dr. Hoare has extracted some tin (in gram quantities) and is ready to supply a small quantity of the metal to anyone sufficiently interested in carrying out a mass-spectrographic analysis.

If this conjecture as to an altered distribution of isotopes should prove to be correct, it will then be the second interesting example of an unsuspected enrichment arising from a prolonged industrial electrolytic process.

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Jan. 18.

Auroral Activity during April–December 1956

FOLLOWING the increasing number of sunspots, the activity of auroræ has also increased considerably in 1956. In particular, some red auroræ appeared between October and December, giving promise of a fine auroral activity during the approaching International Geophysical Year, 1957–58.

On the night of April 21–22, 1956, a series of very high rays lying in the sunlit atmosphere was measured; they appeared in the morning of April 22 and ended with a corona persisting even when the dawn had advanced so much that only first magnitude stars were visible.

Among my stations, Oslo, Askim and Holmestrand were in action and the height and position of sunlit rays near the zenith were measured with base lines of between 47 and 56 km. We found the following great heights for the upper part of these rays (in km.): 514, 697, 829, 1,077, 760, 573, 860, 677, 1,088, 1,079, 749. The bases of the rays were at 279, 313, 181, 200, 271, 229, 181, 200, 271, 229, 282, 305, 202 km.

On October 26–27, a very strong red colour was seen over great parts of the sky, with long red rays, between 20h. and 20h. 30m. G.M.T. Two of my aurora stations, Oslo and Askim, secured good simultaneous pictures of long red rays in the east towards the zenith between 20h. 18m. and 20h. 21m. Heights varied from 308 km. (base) to more than 750 km. (summit). The rays were situated in the Earth's shadow.

After midnight on November 14–15, a great many single pictures of fine aurora even to the south of the zenith were obtained with very fine red spots between the yellow-green auroral rays. No height measurements were, however, obtained.

On November 22–23, twenty-seven days after the aurora of October 26–27, a very similar aurora recurred with a remarkable red ray between 21h. 26m. and 21h. 28m. G.M.T. A series of five simultaneous pictures of this ray were taken from three stations, Oslo (*M*), Nordsæter (*NO*) and Kongsberg (*K*), the base-line *M–NO* being about 138 km. and of *K–NO* about 176 km. These pictures gave a good determination of height and position. The ray was situated very far away, over a region near the border line of northern Finland and the U.S.S.R., about 1,100 km. from Oslo. The foot and summit of the ray were at about 150 and 680 km., in the Earth's shadow. Measurements of the same points with base lines *M–NO* and *K–NO* gave good agreement.

It is hoped that this auroral activity recurs in the spring of this year and will be still more enhanced during the coming Geophysical Year.

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Jan. 23.

Influence of Pressure on the Dielectric Properties of Ice

EXPERIMENTS have recently been performed in which the effects of pressure on the electrical properties of ice were studied. The stress applied was compression between two plates which formed the measuring capacitor. Samples measured included a polycrystalline specimen having coarse- and fine-

grained structure and single crystals cut parallel to, perpendicular to, and at 45° to the *c*-axis. The stress was a static compression of about 2 kgm./cm.² applied at the start of each measurement. The sample holder was connected to a *G.R.* 816-*C* radiofrequency bridge which was balanced at 1 kc. before the load was applied. An oscilloscope was used as an indicator. The sample was then loaded and the oscilloscope deflexion was observed as a function of the time. The bridge was rebalanced at the end of each run. Since the balance is extremely sensitive to temperature fluctuations, special precautions had to be taken.

The results show that there is a real but small change which takes place when pressure is applied. It appears that cold working of the sample occurs, making the experiments only qualitatively reproducible.

Several features of the results are notable.

(1) At a given temperature the effects in polycrystalline samples are an order of magnitude, or more, greater than for single crystals. At temperatures less than − 10° C. no deflexion was observable at the loading mentioned above with single crystals. Greater loading produced a deflexion.

(2) No instantaneous deflexion was observed, indicating that the elastic deformation of the crystal did not alter its electrical properties appreciably.

(3) For polycrystals, the deflexion versus time curves were asymptotic to the deflexion axis at the origin. For single crystals, they seemed to have a finite initial slope. This indicates that different laws govern the two cases. A somewhat similar result has been reported for the mechanical deformation of crystals[1].

(4) Sudden changes were occasionally observed for both single-crystal and polycrystalline samples.

(5) Ordinarily, loading caused a deflexion which indicated greater dissipation of electrical energy in the crystal. However, several cases were observed in which the deflexion upon loading was in the opposite direction. Only one of these cases was for a single crystal and that for pressure applied at 45° to the *c*-axis.

(6) When the load was removed, the deflexion usually decayed slowly and smoothly but not back to zero. However, for polycrystalline samples it would occasionally go beyond zero and often in such a way that the curve was not smooth.

(7) The behaviour for single crystals is very much the same for all sample orientations. (It may be somewhat less pronounced for pressure applied along the *c*-axis.) In this respect it differs from mechanical strain, which seems to be negligible except for stresses applied at 45° to the *c*-axis[1].

A possible interpretation of these results is that the electrical measurements are sensitive mainly to defect structures in the crystal but to a different type, or group of types, from those controlling mechanical deformation. It seems to follow that these defects can either be created or 'destroyed' by stressing the sample.

The discontinuities observed occasionally may well result from discontinuous change of internal stress.

The results for polycrystals are different from those for single crystals not only in magnitude, but apparently in character as well. It might be expected that the former reflect a surface (really interface) property and the latter a bulk property of the samples.

This work was carried out under contract for the Snow, Ice and Permafrost Research Establishment, Corps of Engineers, U.S. Army.

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P. Camp

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Polytechnic Institute of Brooklyn,
New York. Jan. 8.

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Torsion and other Mean First-passage Time Analogies

In an attempt to cover the known mean first-passage time formulæ by Furth[1] and others by a general theory of first-passage times of diffusing (Brownian) particles, some new formulæ and some general results were derived in a recent paper[2]. It was shown there that the average time taken by a particle starting from a point P_0 in a given region R to reach the boundary B of R is, in slightly changed notation,

$$t = \Psi(P_0)/(2D) \quad (1)$$

where

$$\nabla^2 \Psi(P) = -2, \text{ for points } P \text{ inside } R \quad (2)$$

and

$$\Psi(P_B) = 0, \text{ for points } P_B \text{ on } B \quad (3)$$

Here D is the appropriate diffusion coefficient (it could refer to rotational diffusion) and ∇^2 is the Laplacian operator appropriate to the space considered. Further, if the initial position of the particle is not specified but is equally likely anywhere within R,

$$\bar{t} = \overline{\Psi(P_0)}/(2D) = \int_R \Psi(P)\mathrm{d}R/(2DA) \quad (4)$$

where $A = \int_R \mathrm{d}R$ is the total extent of the region (area or volume, whichever is applicable).

In this notation it is apparent that in two dimensions the function $\Psi(P) = \Psi(x,y)$ is identical with the Prandtl torsion function[3-5] for a cylinder the cross-sections R of which are perpendicular to the Z-axis. (The partial derivatives of Ψ are proportional to the stresses under torsion.) Also,

$$H = 2\iint_R \Psi(x,y)\,\mathrm{d}x\mathrm{d}y \quad (5)$$

a purely geometrical quantity, is the torsion modulus; $H = M/(\alpha\mu)$, where M, α, μ are the couple, twist per unit length, and shear modulus, respectively. Thus the torsion problem for solid sections has another analogy in the mean first-passage time problem, in addition to the membrane and viscous-flow-in-a-pipe and other well-known analogies.

The mathematical analogy of the membrane problem to (1) and (4) is even closer. If a membrane is stretched over a region R bounded by B in the X,Y plane, the perpendicular displacement at (x,y) is

$$z = \Psi(x,y)/(2\sigma/p) \quad (6)$$

where σ is the surface tension and p is the excess pressure on one side of the membrane. Similarly, the velocity at (x,y) of slow viscous flow parallel to the Z-axis in a long tube of cross-section R is

$$v = \Psi(x,y)/(2\eta/G) \quad (7)$$

where η is the viscosity and G is the negative pressure gradient. Thus, if V is the volume under the mem-

brane (6), and Q is the total volume of liquid passing any cross-section per unit time in (7),

$$DAt = \sigma V/p = \eta Q/G = H/4 \qquad (8)$$

Since the torsion problem has been solved for many cross-sections, the corresponding solutions for mean first-passage time problems will be known also (in a finite form only for the circle, ellipse, equilateral triangle, and a few special curves). Conversely, an experimental arrangement is conceivable which might be used to determine by means of (1) the torsion function for cross-sections R for which the numerical evaluation is difficult: diffusing particles are observed microscopically, the field of view being restricted to an area of the same shape as the section. If practicable, such a method (refined by photographic techniques) could be superior to the one based on the membrane analogy where only small curvatures are possible and gravity interferes.

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Jan. 16.

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An Explanation of the Tanberg Effect

WHEN an arc discharge at very low pressure passes between metal electrodes the cathode experiences a force directed away from the anode. By suspending a copper cathode on a pendulum and observing the deflexion Tanberg[1] measured this force. At the same time he measured the rate of evaporation of cathode material. With these data he obtained the velocity of the evaporating atoms from Newton's laws of motion. From a force of 20 dynes/amp. and a rate of evaporation of 10^{-4} gm./coulomb, he estimated that the copper atoms left the cathode with a velocity of about 10^{5} cm./sec. He suggested from this that the cathode was at a temperature of about 5×10^{5} deg. C. Up to the present his claim has caused some concern. Opinions are divided into two groups: those who question the accuracy of the experiments and those who disbelieve in Newton's laws. However, other evidence[2-4] tends to support Tanberg's measurements.

In connexion with our recently proposed theory of the cathode spot[5] a novel explanation of this effect emerges. Some of the evaporated atoms are ionized in the region above the cathode and are returned to the cathode by the electric field. Because of the dense vapour the positive ions make many collisions and transfer momentum to the neutral vapour, as a result of which vapour atoms are also returned to the cathode. It is easy to show that if positive ions fall freely in the field of their space charge towards the cathode the latter experiences no net force, since the momentum delivered by the ions on arrival is balanced by the electric stress at the cathode surface. If, on the other hand, the ions move through dense vapour a large fraction of this momentum is transferred to the neutral vapour, which in turn transfers it to the cathode; the remainder of the momentum is carried by the ions. Thus the cathode still experiences no net force. (The momentum associated with electron emission is negligible.)

An interesting point arises now from the balance of numbers. If z atoms/sec. of mass m leave the cathode surface with velocity v, the force of reaction is $f = z.m.v.$ dynes. If z' atoms/sec. return to the cathode as a result of collisions with the ions, the net evaporation is reduced to $z-z'$ and this is the quantity which has been measured throughout. An estimate of z' follows from the new arc theory[5]. To release 1 ampere of electrons from the cathode, $z' \approx 10^{19}$ excited atoms must return per second. The measured evaporation of 10^{-5} gm./coulomb corresponds to $z-z' \approx 10^{17}$ atoms/sec. However, the measured force is caused by z, the gross evaporation. On this basis, we find from Newton's laws and Tanberg's results the velocities of evaporating atoms to be $v = f/z.m. \approx 10^{4}$ cm./sec., that is, reasonable thermal velocities. It transpires that our ideas about the importance of back-scattering in the cathode region and the significant difference between gross and net evaporation resolve all the difficulties previously associated with the Tanberg effect.

A. E. ROBSON
A. VON ENGEL

Clarendon Laboratory,
Oxford. Jan. 14.

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Microphonic Effect of the Larynx

IN order to test a hypothesis[1] on the origin of the vibrations of the vocal folds—the vibrations were supposed to start *coup pour coup* at a contraction of the m. vocalis internus induced by an action potential along the corresponding fibres in the n. recurrens—we made some simultaneous recordings on the electromyogram of the m. thyreo-arytenoideus and the sound curve with a very suitable patient in Prof. H. A. E. van Dishoeck's Otorhinolaryngological Clinic, University of Leyden. This patient had a stoma just above the larynx and the internal laryngeal muscles presented themselves directly. One vocal fold was normal, the other one was slightly less movable. Phonation was practically normal; the patient only used the chest voice. Two very thin needle electrodes were put into the normal m. thyreo-arytenoideus, about 1·5 mm. from the glottis and about 1·5 mm. deep, one at the anterior side, the other one near the arytenoid. We thus recorded the myogram of the whole muscle instead of the activity of a small part, as is done with thin concentric needle electrodes.

When the electrodes were well fixed into the muscle, results as shown in Fig. 1 were obtained. A perfect synchronism between the myograms and their sound curves is to be observed. The myogram is in fact, however, a microphonic effect of the larynx, being passive in nature. The effect is caused by the passive simultaneous deformation of all the muscle fibres and their membranes as a result of the vibration of the vocal folds. This microphonic effect is comparable with the well-known Wever and Bray microphonic effect of the cochlea and the microphonic effect of the semicircular canals[2]. It can be

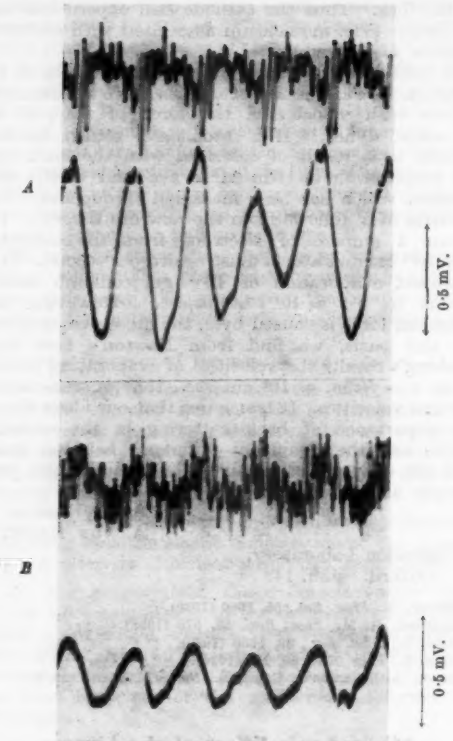

Fig. 1. Microphonic effect of the larynx. Vowel *a*, fundamental frequency 122·5 cycles per second, *A*, and 137 cycles per second, *B*. Upper curves, sound pressure; lower curves, electromyogram of a vocal fold, needle electrodes. The corresponding curves are synchronous. The passive variations (deformation, microphonic effect) are much greater than the active variations (spikes)

seen that the vibration contains but few higher harmonics, in agreement with the results of Trendelenburg and Wullstein[3] on excised larynges and theoretical considerations[4] on the mechanism of vibration.

From the point of view of the above hypothesis it is very difficult to explain why there is no indication of a synchronous activity of the muscle fibres (spikes) to be found on the curves. As a matter of fact the tensions developed at a spike have a magnitude of 100 mV. and are thus large compared with the tensions associated with a passive deformation, which must necessarily be subliminal. When the fibres contract synchronously and start each new cycle, nevertheless, this means that only a few fibres are working in the chest register. But then the muscular forces would be very small compared with the forces developed by the air stream, thus being unimportant. The results are easily explained, however, on the basis of the myo-elastic theory[5] of voice production, as this theory does not demand a synchronous activity of the fibres. The potentials associated with the synchronous passive deformation of all the fibres will enter into a recording such as we made, but the activities of the different fibres, being asynchronous, tend to cancel out, in contrast with the recording of the potentials of a small region with concentric needle electrodes, which necessarily shows active variations large compared with the passive variations[6].

The microphonic effect of the larynx will manifest itself in all the recordings of the potentials of a rather large region of the internal laryngeal muscles or the muscles and nervous structures directly connected with the larynx. In our opinion, this is the explanation for a synchronism[7] claimed between the potentials in the n. recurrens and the sound pattern.

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Anomalous Spectral Absorption of Complexed Neodymium Ions

The formation of complexes of lanthanon ions is reflected in variations in the absorption spectra of their solutions or of the reflexion spectra of their solid salts. Some of these variations have been examined in studies on lanthanon complexes[1]; but thus far there is extant no direct correlation of variations in absorption spectra with the stabilities of complexes formed with a series of homologous ligands.

Over the past several years I have undertaken such a study, and a preliminary evaluation of the results obtained is shortly to be submitted for publication elsewhere. Within this study there has been observed a completely anomalous phenomenon not hitherto recorded which appears of such interest as to warrant early, brief recording.

Major variations observed in the absorption spectrum of the Nd^{3+} ion upon complex formation are: shifting of the bands, especially the main one at 576 mμ, from their normal frequencies, increase in optical density of the bands, and widening due to 'internal' Stark effect splitting. It might be expected that band shifts should be directly comparable with stabilities of the complexes formed, application of the simple de Broglie–Schrödinger equation yielding energy data directly correlatable with those obtained by potentiometric or polarographic determination of thermodynamic stability constants. There is now seen a drastic limitation to this treatment.

Table 1 lists band shifts (from 576 mμ), energy and stability constant data for neodymium complexes with a series of aliphatic carboxylic acids. There exists quite clearly a discontinuity in correlation as one passes from monocarboxylic to di- and polycarboxylic. With mono- and α-carboxylic acids as the complexing liganda, shift of the 576 mμ absorption band to lower frequencies is paralleled by a decrease in log $\overline{K}$ values—this is in conformity with energy requirements for complex formation with these ligands. With dibasic, and higher, carboxylic acids, however, this situation is reversed, and increasing band-shifts towards lower-energy levels are associated

Table 1

Complexing carboxylic ions	Band shift from 5760 A.	Energy difference $\bar{V} \times 10^{-4}$	log $\bar{K}$
Monobasic			
Formic	10	0·41	5·9
Acetic	60	2·48	6·6
Propionic	80	3·31	6·4
Butyric	100	4·14	6·3
iso-Butyric	80	3·31	6·2
Valeric	120	4·97	5·0
Caprylic	130	5·38	4·4
Capric	140	5·80	4·0
α-Carboxyl			
Glyoxalic	40	1·66	6·8
Pyruvic	90	3·73	6·1
Dibasic			
Oxalic	50	2·07	11·9
Malonic	40	1·66	9·1
Succinic	10	0·41	8·1
Glutaric	0	0	6·9
Unsaturated dibasic			
Fumaric	50	2·07	7·5
Hydroxy			
Glycollic	40	1·66	7·1
Lactic	50	2·07	8·0
Malic	60	2·48	8·4
Tartaric	60	2·48	9·0
Citric	70	2·90	11·1
Amino			
Glycine	80	3·31	11·4
Alanine	80	3·31	11·9
'Trilo'	90	3·73	11·0
'Enta'	120	4·94	16·8

with increasing values of log $\bar{K}$. This effect is not one of momentary observation but one which has been continuously checked and noted through a series of some 800 observations. Further examination of the data obtained is being made in an attempt to elucidate this fundamental variation.

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Dioxanates of Cadmium Chloride

Dioxanates of cadmium chloride were precipitated from a solution of the anhydrous salts (certified purity) in acetal-free dioxane, prepared from Eastman Kodak technical 1,4-dioxane by the method of Eigenberger[1]. The crude dioxanate (that is, wet with dioxane) was placed in the bulb of the isotenoscope of Smith and Menzies[2], and oil of paraffin, U.S.P., was employed as the levelling liquid. The isotenoscope was immersed in a water-bath maintained at 25·5° ± 0·1° C. The system was evacuated and the pressure values were taken continuously until the lowest value was obtained. The pressures were read on a Zimmerly gauge by means of a cathetometer.

Constant vapour pressure-levels were obtained at the values: 36·80, 28·55, 25·40, 23·70, 19·10 mm. mercury and a lower level ranging from 15·00 to 16·90 mm. mercury. The experimental vapour pressure of pure dioxane at the temperature under study was found to be 37·08 ± 0·02 mm. mercury.

Two stable dioxanates have previously been reported[3,4]: $CdCl_2$.dioxane and $CdCl_2$.$\frac{1}{2}$ dioxane. Interpretation of the constant pressure-level based on Gibbs's phase rule indicates the existence of at least four stable or metastable dioxanates. It is apparent thus that two or more dioxanates of cadmium chloride exist other than those previously reported. The lower pressure-levels, 15·00–16·90 mm., correspond to the vapour pressures of solid dioxane crystallized in the iced vapour trap used in the system.

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Compressibilities of Sodium and Potassium Hydroxides

Gucker[1], on the basis of the Debye–Hückel theory, found that the apparent molar compressibility of aqueous solutions of electrolytes conforms to the relation $\varphi(k_s) = \varphi^0(k_s) + S_k C^{1/2}$, where $\varphi(k_s)$ is the apparent molar compressibility at molar concentration C and $\varphi^0(k_s)$ at infinite dilution. S_k is a constant. Similarly, the adiabatic compressibility was found to follow the relation $\beta = \beta_0 + AC + BC^{3/2}$ (Bachem[2]), where β is the adiabatic compressibility at molar concentration C and β_0 is that of water, while A and B are constants.

Using the optical diffraction method, ultrasonic velocities in aqueous solutions of sodium hydroxide and potassium hydroxide have been determined in the frequency range 5–30 Mc./s. Adiabatic and apparent molar compressibilities are computed using the equations:

$$\beta = 1/V^2 d \qquad (1)$$

and

$$\varphi(k_s) = \frac{1000\beta}{C} - \frac{\beta_0}{d_0}\left\{\frac{1,000\,d}{C} - M_2\right\} \qquad (2)$$

where V is the ultrasonic velocity, d the density of the solution, d_0 the density of water and β_0 the compressibility of water and M_2 the molecular weight of the solute.

Ultrasonic velocity, V, and adiabatic compressibility, β, as functions of concentration C are represented in Fig. 1.

Sodium hydroxide. Ultrasonic velocity is a linear function of concentration in the range 0–6·3 moles/litre. The variation of adiabatic compressibility shows a peculiar behaviour. The entire range can be divided into two regions, each one following Bachem's relation with different sets of constants. One set of constants ($A = -9·38 \times 10^{-6}$; $B = 2·22 \times 10^{-6}$) satisfies the relation from 0 to 1·5 moles/litre and another set ($A = -8·21 \times 10^{-6}$; $B = 1·69 \times 10^{-6}$) holds good in the range 1·5–6·4 moles/litre. In spite of this, the apparent molar compressibility satisfies Gucker's relation with one set of constants.

Potassium hydroxide. In this case, ultrasonic velocity exhibits a peculiarity. The graph of velocity against concentration consists of two straight lines with slightly different gradients: one in the region 0–4·23 moles/litre and the other in the range 4·23–8·0 moles/litre. The difference in the gradients is quite definite though small.

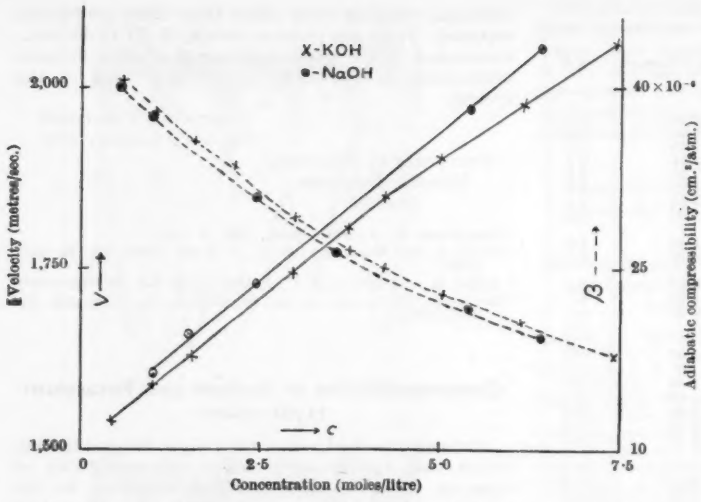

Fig. 1. ——, Ultrasonic velocity against concentration; - - - - -, adiabatic compressibility against concentration

As regards the variation of β, the whole range is divided into two regions. One set of constants ($A = -7{\cdot}79 \times 10^{-6}$; $B = 1{\cdot}54 \times 10^{-8}$) satisfies the relation from 0 to 4·23 moles/litre and another set ($A = -7{\cdot}13 \times 10^{-6}$ and $B = 1{\cdot}30 \times 10^{-8}$) holds good in the range 4·23–7·5 moles/litre.

Though the graphs of velocity against concentration and of β against molar concentration divide into two parts, the apparent molar compressibility is satisfied by a single Gucker relation. It may be remarked here that the graph of the apparent molar volume against the square root of the concentration also shows a break at about 5 moles in this case[3].

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Ore Mineral Identification Simplified

An electric cell photometer, described by one of us[1] in 1954, has been used successfully in conjunction with a micro-indentation hardness tester for the rapid identification of ore minerals in polished section. The hardness tester is a G.K.N. bench type instrument, manufactured by Hall Telephone Accessories, Ltd.

In the technique employed both the photometer and hardness tester are fitted to the same standard ore microscope. The reflectivity of the unknown mineral is measured relative to a known standard using tungsten filament illumination of specified colour temperature. This measurement can be made on mineral grains down to about 30μ in diameter with a precision of 1 per cent. The hardness of the same unknown can be determined immediately after the reflectivity measurement, merely by rotating the diamond pyramid of the hardness tester into the position of the objective, making the indentation, returning the objective to its original position and measuring the size of the indentation. The positioning of the indentation can be made with a precision of less than 5μ. A Vickers 136° pyramid is used for making the indentation and the hardness is expressed in terms of Vickers hardness numbers.

The results of twenty-five reflectivity determinations and micro-indentation hardness measurements are plotted in Fig. 1 to show the variations encountered among common ore minerals. The distribution of the values illustrates the ease with which certain minerals of similar reflectivity can be differentiated by their indentation hardness and vice versa.

The data for both reflectivity and hardness are mean values obtained on a number of randomly orientated sections. The ranges due to reflexion anisotropy and to directional variations in hardness have been omitted for clarity, though both these properties are valuable aids to identification in some instances.

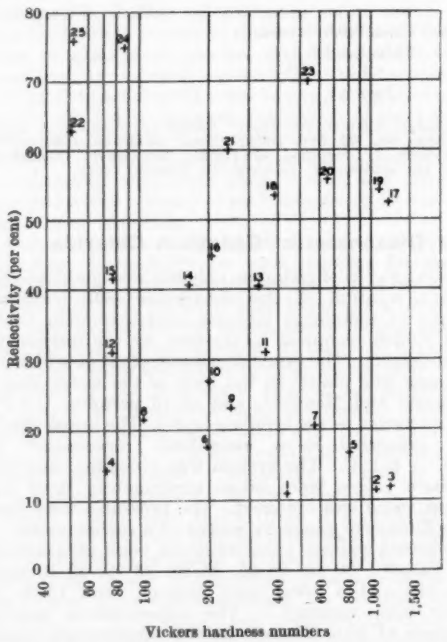

Fig. 1. Mean values of reflectivity and hardness for twenty-five common ore minerals

1 Betafite	7 Magnetite	13 Pyrrhotite	19 Pyrite
2 Cassiterite	8 Bornite	14 Boulangerite	20 Skutterudite
3 Chromite	9 Alabandite	15 Galena	21 Krennerite
4 Covellite	10 Cuprite	16 Chalcopyrite	22 Altaite
5 Uraninite	11 Tetrahedrite	17 Cobaltite	23 Platinum
6 Blende	12 Stibnite	18 Niccolite	24 Antimony
		25 Gold	

A system of ore mineral identification based primarily on reflectivity and micro-indentation hardness has been evolved and has proved more satisfactory than any other used hitherto. Each measurement normally takes less than one minute to complete and when the values obtained are used in conjunction with other easily observed properties such as colour, anisotropism and reflexion pleochroism, most ore minerals can be satisfactorily identified without recourse to spectrographic or X-ray methods.

Full details of the photoelectric cell apparatus and of the micro-indentation hardness tester will be published elsewhere in due course.

This work is published by permission of the Director of the Geological Survey of Great Britain.

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Plethysmometric Measurement of Swelling in the Feet of Small Laboratory Animals

Various authors have described phlethysmometric[1-3] and planimetric[4-6] methods of measuring the volume of rats' and guinea pigs' feet before and after the injection of irritant substances. Such methods have formed the basis for the determination of the anti-inflammatory activity of adrenal steroids and other agents, and for the measurement of the local response to injections of histamine and histamine-releasing agents.

In the course of an investigation into the anti-inflammatory action of some adrenocorticoids we have developed a plethysmometric method of measuring accurately the volumes of the feet of rats and mice. We have found this method to be superior in its use to existing methods.

The apparatus (Fig. 1) consists of a modified 2-ml. microburette connected to a 5-ml. glass syringe. Carbon tetrachloride, coloured by the addition of solid sudan III, fills the lower part of the apparatus, and the upper part contains water, to which a few drops of suitable surface-active agent have been added. The wide mouth of the burette is graduated with two marks, *A* approximately 1·5 cm. below the rim and *B* approximately 5·0 cm. below the rim.

The rat or mouse is anæsthetized by an intraperitoneal injection of 50 mgm./kgm. sodium amytal. It is important that the anæsthesia is sufficiently deep to produce a completely flaccid leg and foot, otherwise discordant readings may result from flexion of the animal's limb during measurement. The level of water is adjusted to the mark *A* by means of the syringe; the reading of the water – carbon tetrachloride interface is observed on the burette scale. The anæsthetized animal's foot is introduced into the mouth of the burette until the tip of the foot coincides with the mark *B*, thus causing the water-level to rise in the burette. The syringe is then withdrawn to bring the water-level back to mark *A*; the reading of the water – carbon tetrachloride interface is again observed on the burette scale. The difference between this and the first reading represents the volume of the animal's foot. With our apparatus the volume can be read off directly to the nearest 0·01 ml.

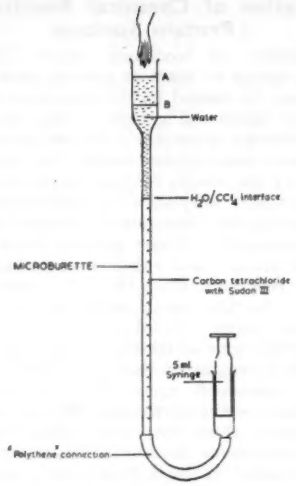

Fig. 1

The apparatus is very simple to use and the determinations both rapid and accurate. In an experiment involving 190 consecutive determinations, the error has been found to be only 1·13 per cent, sufficiently small to be disregarded. Our experiments have shown that the degree of swelling of a formalin-induced inflammation in the rat foot can be followed over a period extending from a few hours to several weeks.

Initial experiments showed that there was no significant difference ($P > 0·9$) between the volume of the rat's right and left hind foot, therefore in our experiments the degree of swelling was estimated by comparing the volume of the treated foot with that of the untreated control.

In our experiments also we thought it of interest to determine the exact location of the swelling, therefore the rats were pretreated with an intravenous injection of Evan's blue thirty minutes before the injection of formalin. The dye was found to be concentrated in the region of swelling. By this means we have been able to measure the swelling accurately and to determine its location.

It is planned to publish these results in greater detail elsewhere.

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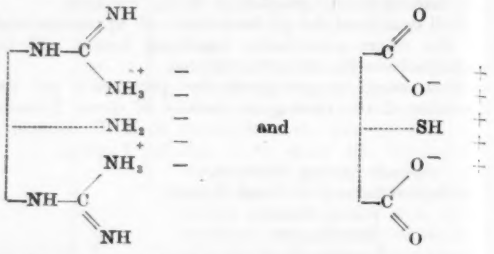
Potentiation of Chemical Reactivities at Protein Surfaces

The ability of toxicants which function as alkylating agents to react at specific sites on protein surfaces may be caused by differences in the reactivities of the functional groups of the side-chains as well as molecular geometry. Several mechanisms by which these reactivities might be modified are suggested by the results of some recent investigations on the kinetics of alkylation of amino-acids, peptides and proteins by the fungicide 2,4-dichloro-6-(*o*-chloroanilino)-*s*-triazine[1]. These studies show that only dissociated amino- and sulphydryl-groups can take part in the reactions, while the NH_3^+ and SH groups are inert. In free amino-acids the latter groups predominate under physiological conditions, so that only small fractions of their potential reactivities are utilized. It is suggested that any structural features in protein molecules giving rise to micro-environments which behave as though they are more acidic or more basic than the surrounding medium can suppress or increase the ionization of the functional groups contained in them, thus giving rise to regions of low and high reactivity on the protein surface. It can be seen that the gains from such situations might be considerable when it is taken into account that only 0·25 per cent of the reaction potential of the amino-group of glycine is utilized at *p*H 7·0.

Two ways by which this might be achieved are suggested by the reaction-rate and ionization constants obtained on small molecules[1,2]. The first of these involves isolation of functional groups from surrounding carboxyl groups. For example, it has been found that asparagine is six times more reactive than aspartic acid, indicating that the second carboxyl group suppresses reactivity by increasing the pK' values of the amino-group (Table 1). On separating the amino- and carboxyl-groups by peptide linkages as in triglycine, the pK' is reduced to 7·91 and the reactivity relative to aspartic acid is increased to 43. The highest degree of potentiation obtainable through isolating an amino-group from surrounding carboxyl groups is represented by the methyl ester of glycine, in which the acid function is suppressed altogether. This compound is 88 times more reactive than aspartic acid at *p*H 7·0. However, the ultimate in reactivity has not been achieved, since *p*-aminobenzoic acid is capable of combining with the *s*-triazine 230 times more rapidly than with aspartic acid. In this case more than 99 per cent of the reaction potential is utilized.

Since 50 per cent of an amino- or sulphydryl-group will be present in reactive form when the pK' of the ionizing group is equal to the *p*H of the medium, a second mechanism must be found by which pK' values can be reduced to 7 or lower in order to utilize the maximum amount of latent reactivity under physiological conditions. It is believed that this can be achieved if the ionizing group is situated in a region rich in positively charged centres having very high pK' values, such as the guanidino-groups of the arginine residue. These would tend to repel protons and attract negatively charged ions, and so create a micro-environment with a higher *p*H than the main body of the solution through the formation of a localized Helmholtz double layer. A larger proportion of the functional group could then ionize to produce an effect equivalent to lower pK' value. Thus the reactivities of functional groups located in environments such as :



could vary considerably.

An inspection of the pK' values compiled by Cohn and Edsall[2] reveals that this can occur to some extent even when the interacting groups are the same. Thus the pK' values of the two amino-groups of cystine are reported to be 7·48 and 9·02, compared with values of 9·0–9·7 for most of the other amino-acids. When proximity to basic groups is coupled with isolation from carboxyl groups, an even greater degree of ionization can occur. Thus the pK' values reported for cystinyl-di-di-glycine are 6·01 and 6·87 respectively, indicating that 55–90 per cent of the amino-groups are present in reactive form at *p*H 7·0.

These examples include only primary amino-groups. However, it is believed that the reactivities of the functional groups of lysine, cysteine and tyrosine residues with electrophilic toxicants might be suppressed or potentiated, depending upon whether they are located in anionic, non-polar or cationic micro-environments. The probability that effects such as these are operative in large molecules is suggested by the recent finding that bovine serum albumin reacts about 100 times more rapidly with 2,4-dichloro-6-(*o*-chloroanilino)-*s*-triazine than would be anticipated from the velocity coefficients of its component amino-acids.

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Table 1. Effect of pK' on the Reactivity of Primary Amino-Groups at *p*H 7·0 relative to Aspartic Acid

Compound	pK'	Relative reactivity
Aspartic acid	9·60	1
Asparagine	8·80	6
Glycine	9·60	7
Triglycine	7·91	43
O-Methyl glycine	7·73	88
p-Aminobenzoic acid	4·02	230

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Isolation of Nucleic Acids from *Micrococcus lysodeikticus*

We have found a simple method for the preparation of a mixture of ribonucleic acid and deoxyribonucleic acid and the preparation of purified deoxyribonucleic acid in a highly polymerized state from cells of *M. lysodeikticus*. In arriving at the techniques, we have taken advantage of the fact that above *p*H 8·0 the activity of the ribonuclease system in *M. lysodeikticus* is negligible. Moreover, in the absence of orthophosphate, polynucleotide phosphorylase (polyase) is inactive toward ribonucleic acid. Therefore, for maximum yields of ribonucleic acid the lysis

of the cells was carried out at *p*H 8·5. To destroy the ribonucleic acid selectively orthophosphate was added[1]. This communication presents some of the preliminary results.

The following is an example of the isolation of a mixture of ribonucleic and deoxyribonucleic acids (NA 5). Acetone-dried cells (14 gm.) from a 48-hr. culture[2] were suspended in 230 ml. of approximately 0·5 per cent sodium chloride to which 100 mgm. of crystalline lysozyme were added. Initial *p*H was 8·8. The mixture was incubated at 37°. Lysis was complete in 1 hr. (In later experiments the concentration of lysozyme was increased to 0·1 per cent to reduce the time for lysis to 30 min.) The highly viscous material was centrifuged at 5° C. for 1 hr. at 28,000*g*. After decanting the supernatant (100 ml.), the sediment was suspended in 350 ml. of 10 per cent sodium chloride. The preparation was then heated to 95° for 30 min. with constant stirring, chilled and centrifuged for 30 min. at 28,000*g*. The supernatant (170 ml.) was decanted and mixed with one volume of 95 per cent ethanol. A copious fibrous precipitate formed, which was removed and dissolved in 10 per cent sodium chloride. The sediment was washed with 1·0 *N* sodium chloride and centrifuged as above. The supernatant was removed and mixed with an equal volume of 95 per cent ethanol. The precipitate formed was added to the 10 per cent sodium chloride solution of nucleic acid and the volume brought up to 100 ml. The mixture was then shaken three times with chloroform or until no gel interface formed. The nucleic acid was then precipitated with an equal volume of 95 per cent ethanol. The pure white fibrous precipitate was washed in 95 per cent ethanol and ether and dried *in vacuo*. Yield was 261 mgm. or 1·85 per cent of the dry weight of the cells. The preparation contained 7·15 per cent phosphorus and had a nitrogen phosphorus ratio of 3·83. After digestion in 1·0 *N* potassium hydroxide at 37° for 18 hr. the fraction of material hydrolysed (ribonucleic acid) was 80·0 per cent, of the material unhydrolysed (deoxyribonucleic acid) 20 per cent (based on phosphate determinations). The ratio of ribonucleic to deoxyribonucleic acid decreases considerably as the time of lysis is increased. One such preparation (NA 6) after a 5-hr. lysis contained only 9 per cent ribonucleic acid. Lysis at low *p*H (6–7) causes a similar drop in ribonucleic acid yields. Table 1 summarizes the findings of three mixed nucleic acid preparations (NA 4–6).

The mixture of nucleic acids is chalky white, fibrous and hygroscopic. It will take up as much as 10 per cent of its weight in water in 30 min. after thorough drying in a desiccator. It has the consistency of methylcellulose when very dry and readily dissolves in distilled water. Solutions of preparations with lower fractions of ribonucleic acid are correspondingly more viscous and are precipitated from salt–ethanol solutions in a form similar to poly *A* [3].

The following is an example of a preparation of deoxyribonucleic acid (NA 20). 10 gm. of acetone-dried cells were suspended in 200 ml. 0·5 per cent sodium chloride to which were added 20 ml. 1·0 *M* sodium hydrogen phosphate and 10 ml. 0·5 *M* *tris*, final *p*H 8·5. After the addition of 200 mgm. of crystalline lysozyme the preparation was incubated for 30 min. at 37°. Then 230 ml. of 20 per cent sodium chloride were added, and the mixture heated to 95° for 30 min. The remainder of the procedure was the same as for the preparation of total nucleic acid with the exception that the orthophosphate was removed by repeated precipitations of the deoxyribonucleic acid preparation with ethanol from 1·0 *N* sodium chloride. Final yield was 78 mgm. or 0·78 per cent. The nitrogen/phosphorus ratio was 3·66. The ribonucleic acid content was 0·65 per cent, orthophosphate 0·57 per cent; ε_p at 258 mμ in 0·1 *N* acetate buffer, *p*H 6·0, was 7,420, $\varepsilon_p(258)/\varepsilon_p(230)$ was 2·05, the intrinsic viscosity in 0·1 *N* potassium chloride (*p*H 5·6), $\eta_{c=0}^{25°}$, was 234 (c = gm. deoxyribonucleic acid/100 ml.) as determined in an Ostwald–Fenske viscometer type 100 (flow time 65 sec.) and based on an assumed phosphorus content of 9·22 per cent.

Table 1

NA preparation	4	5	6	20	21	23
Lysis time (in hr.)	1·0	0·5	5·0	0·5	0·5	0·5
Orthophosphate	−	−	−	+	+	+
Temperature of extn.	95°	95°	95°	95°	95°	−5°
Yield (gm.) (per cent)	1·85	1·85	0·45	0·78	0·82	0·49
N/P	3·9	3·83	4·02	3·66	3·95	3·84
ε_p(260 mμ)	8,600	8,550	6,970	7,420	7,400	7,430
ε_p(260 mμ) / ε_p(230 mμ)	3·0	2·56	1·96	2·05	1·81	3·26
ε_p(260 mμ) / ε_p(290 mμ)	4·63	2·65	3·36	3·60	3·60	4·53
$\eta_{c=0}$	—	—	—	234	175	180
Ribonucleic acid (per cent)	69	80	9	0·57	3·0	12·0
Deoxyribonucleic acid (per cent)	31	20	91	98·7	97·0	87·0
Orthophosphate (per cent)	—	—	—	0·65	0	1·0

While these studies were in progress a method for extracting deoxyribonucleic acid from bacteria other than *M. lysodeikticus* was published by Vendrely *et al.*[4]. Earlier, the isolation of material from *M. lysodeikticus* was reported by Frisch-Niggermeyer[5] and tentatively identified as deoxyribonucleic acid by its absorption curve and by the action of deoxyribonuclease on lysed cells. The present findings indicate that this organism is an excellent source for bacterial deoxyribonucleic acid.

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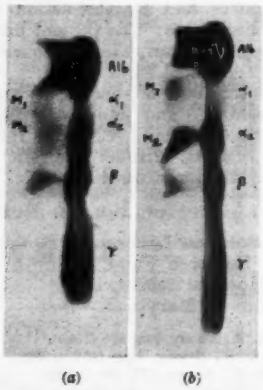
Two-Dimensional Agar Electrophoresis of Serum Mucoproteins

The agar electrophoresis technique developed in this laboratory[1,2] has been adapted to two-stage and two-dimensional procedure for demonstrating the micro-heterogeneity of the main protein components of human serum[3]. Recently, Markham[4] reported a method of two-dimensional paper electrophoresis for the separation of mucoproteins. The method is elaborate, and the separations achieved are not satisfactory, diffused zones being obtained as a result of trailing due to adsorption of the proteins on paper at the acid *p*H. The present communication gives a brief description of a simple method of two-dimensional agar electrophoresis, by which the mucoproteins can be separated into well-defined zones.

The method consists in the separation of the main protein components of serum at *p*H 8·6 (veronal–acetate buffer, 0·05 ionic strength) on agar gel (1 per cent, 7–8 c.c.) layered into the space (18 cm. × 2·5 cm.) provided by a 'Perspex' frame kept on a square plate glass (18·5 cm. × 18·5 cm.). The serum sample (15 μl.) is applied to a small Whatman No. 1 paper disk (6 mm. diam.) and placed at the centre on the surface of the agar gel. Another paper disk of the same size is soaked in 0·2 per cent amidoschwarz dye and superimposed on the serum paper disk. The dye serves as marker for albumin. After electrophoresis (200 V.; 7–8 m.amp., 4 hr., 22–24° C.) the paper disks and the excess of the gel layer on both sides of the protein zone are removed. This can be easily achieved by noting the position of the albumin spot which is stained by the dye. The gel strip (8 mm. wide) containing the main protein components is retained on the plate glass. Another lot of agar gel (1 per cent, 20 c.c.) containing acetic acid–acetate buffer of *p*H 4·5 and ionic strength 0·05 is layered into the space (14·5 cm. × 14·5 cm.) provided by a 'Perspex' frame so as to immerse completely the agar gel strip containing the main protein fractions. The electrophoresis is carried out at right angles to the first direction for 6–8 hr. at 100–120 V.; 8–9 m.amp. After electrophoresis the agar gel layer is dried in a current of air at room temperature and subjected to the staining procedure using amidoschwarz dye[1,2]. Typical patterns of normal and cancer serum are shown in Fig. 1*a* and *b*. The patterns show the separation of four protein components having the mobilities of albumin, α_1-, α_2- and β-globulins at *p*H 8·6 and migrating towards the anode after the second electrophoresis at *p*H 4·5. In the case of cancer serum the intensity of the spots relating to M_1 (having the mobility of α_1-globulin at *p*H 8·6) and M_2 (mobility of α_2 at *p*H 8·6) mucoproteins is more than the corresponding protein fractions of normal serum.



(*a*) (*b*)

Fig. 1. Two-dimensional agar electrophoresis patterns of human serum. (*a*) Normal serum; (*b*) cancer (check) serum

The mucoproteins can be stained with fuchsin sulphite after periodate oxidation. The marker is not added when the agar film is stained for carbohydrates. The mucoprotein M_1 contains a large percentage of carbohydrate, as indicated by the intensity of the colour obtained after staining with fuchsin. When the agar plate is subjected to the successive staining procedure with fuchsin sulphite followed by amidoschwarz, the mucoprotein M_1 is stained more densely for carbohydrate than for protein as indicated by the predominance of pink colour of the spot, thereby indicating the large percentage of carbohydrate in this component. The other component (M_2) having the mobility of α_2-globulin at *p*H 8·6 also gives a test for carbohydrate; but the concentration of the carbohydrate is lower than in the M_1 component, while the protein concentration is high. The components having the mobilities of β-globulin and albumin at *p*H 8·6 also give a reaction for carbohydrate. Thus four protein components of anodic mobility at *p*H 4·5 and having the mobilities of albumin, α_1-, α_2- and β-globulins at *p*H 8·6 are present in human serum. Further work on the development of a quantitative method for the analysis of these proteins by eluting the colour of the spots after electrophoresis on 'Cellophane' or polyester films[5,6] is in progress. The technique, being simple and elegant, can be used for routine examination of the changes in mucoproteins in pathological samples of blood serum. Further investigations on the isolation and characterization of the four serum protein components having anodic mobility at *p*H 4·5 and their occurrence in different animals are in progress. It is hoped that the use of this technique will facilitate the investigations of mucoproteins in serum and urine.

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Relationship of Complement to Blood Coagulation

The factors that constitute the complement system and those essential for blood coagulation are proteins which have very similar physical properties. These similarities have attracted the attention of numerous workers who have attempted to define the interrelationship of these factors. It was originally thought that prothrombin and the C^11 component of complement were identical[1], but this has been since shown to be erroneous[2,3].

Conflicting evidence exists, however, to show that when serum or plasma is treated by heat, ammonia, zymin heparin or decalcifying salts both the activity of complement and fibrin formation may be impaired[4].

These observed facts suggested that one of the other factors essential for normal blood coagulation

could be the common factor to both systems. Modern advances have shown that the initial stage of blood coagulation involves the interaction of several factors, namely, antihæmophilic globulin, Christmas factor, platelets and factor V, to form active thromboplastin which in turn is capable of activating prothrombin to thrombin[5]. Factor VII, once thought to be essential for active thromboplastin formation, is now believed to be required only for the action of tissue thromboplastin on prothrombin[6].

If complement is related to any of these plasma or serum factors, it is not unreasonable to suppose that a congenital or acquired defect of a factor would be associated with a significant decrease or increase in the level of complement.

Serum from severely affected cases of hæmophilia, Christmas disease, factor V deficiency and cases treated with 'Dindevan' (factor VII deficient)[7] were examined for their content of complement as compared with normal blood examined under identical conditions.

In order to ensure accurate comparison the sera were derived from blood collected in siliconed glass without added anticoagulant. Platelet-rich plasma derived from these samples at 0° C. was allowed to clot at 37° C. in glass and the fibrin once formed removed. The resultant serum was tested for its titre of complement. While the platelet-rich samples undergo coagulation the platelets undergo a process of agglutination or lysis, at the same time releasing factors essential for hæmostasis and fibrin formation. As this process of cellular lysis might fix or destroy complement the titre of serum samples from platelet-free fractions obtained by differential centrifugation were compared with those of the sera from platelet-rich plasma (Table 1).

No significant difference in the level of complement was discovered between normal serum and serum derived from selected cases with specific coagulation defects. Similarly, there was no difference between sera from platelet-rich and platelet-free plasma.

It is unlikely, therefore, that antihæmophilic globulin, Christmas factor, factor V or VII are in any way related to complement or that complement is fixed during the interaction of these factors during blood coagulation. Neither is complement fixed by physiological agglutination or lysis of blood platelets.

Table 1. COMPLEMENT TITRES
1 volume serum + 1 volume 1·5 per cent sensitized sheep cell suspension

Serum	Complement titre (50 per cent) hæmolysis
Normal 1	1/16
Normal 2	1/24
Normal 3	1/16
Normal 4	1/32
Hæmophilia 1	1/16
Hæmophilia 2	1/16
Christmas disease 1	1/16
Christmas disease 2	1/24
'Dindevan' 1 } Factor VII	1/32
'Dindevan' 2 } deficiency	1/32
Factor V deficiency	1/32
Platelet-rich 1	1/24
Platelet-free 1	1/16
Platelet-rich 2	1/12
Platelet-free 2	1/16
Platelet-rich 3	1/24
Platelet-free 3	1/24
Platelet-rich 4	1/32
Platelet-free 4	1/32
Platelet-rich 5	1/32
Platelet-free 5	1/32

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Role of the Kidney in Erythropoiesis

RECENT observations in our laboratory indicate that the dynamic equilibrium of the erythron is controlled by the relationship of oxygen supply in the tissue to the demand for oxygen rather than by either alone. Conditions that reduce the demand for oxygen while the supply remains normal (acute starvation and the condition following hypophysectomy) and ones that increase the supply of oxygen while the demand remains normal (transfusion-induced polycythæmia and hyperoxia) all produce a profound decrease in erythropoiesis in rats. These animals give an exaggerated erythropoietic response to the injection of plasma rich in erythropoietin (anæmic plasma)[1].

Measures that increase the demand for oxygen while the supply remains normal (dinitrophenol or triiodothyronine) or that decrease the supply while the demand remains normal (bleeding or phenylhydrazine-induced hæmolysis) increase erythropoiesis in rats. Bleeding and the administration of phenylhydrazine constitute the standard procedures to obtain plasma with high erythropoietic activity.

Previous attempts to determine the site of formation of erythropoietin by surgical removal of organs[2] and by organ extracts have been unsuccessful[3]. With the sensitive assay methods available and the demonstration that a single dose of cobaltous chloride or an acute massive hæmorrhage greatly elevates the plasma erythropoietin-level of rats and rabbits within 10–12 hr.[4], we have been able to study this problem more thoroughly. We have reported that rats which have been subjected to hypophysectomy, thyroidectomy, splenectomy, adrenalectomy and gonadectomy retain the capacity to respond to repeated phlebotomy with an increase in the plasma content of erythropoietin which is comparable with that observed in similarly bled normal animals[5]. In addition, we have found that removal of seven-eighths of the liver, or removal of adrenals, spleen, pancreas, stomach, or intestines from the rat does not lessen the response to an injection of cobalt.

After bilateral nephrectomy, neither rats nor rabbits have the capacity to respond to a single dose of cobaltous chloride or a single massive hæmorrhage by an elevation of plasma erythropoietin. As shown in Table 1, the plasma obtained from the blood of

Table 1. Effect of Nephrectomy on Erythropoietin Production in Rats

Condition of donor	Stimulus	Assay of plasma (percentage of iron-59 incorporated into RBC)
Normal	Cobalt	9·8
Nephrectomized	Cobalt	2·4
Ureters ligated	Cobalt	5·5
Control	(Saline)	2·6
Normal (hæmatocrit 25)	Bleeding	15·4
Nephrectomized (hæmatocrit 33)	Bleeding	6·0
Adrenalectomized (hæmatocrit 35)	Bleeding	11·3
Control	(Saline)	6·9

In the first group the rats were injected with 76 μM cobalt chloride immediately after nephrectomy and 12 hr. after ureter ligation. The plasma was sampled 12 hr. after cobalt administration and assayed in starved rats. In the second group the rats were bled (6 ml.) immediately after operation, the plasma sampled 7 hr. later and then assayed in starved rats. A minimum of 5 rats was included in each group.

nephrectomized rats withdrawn 10–12 hr. after the injection of cobaltous chloride or after bleeding contains no erythropoietic activity as measured by the incorporation of iron-59 into the erythrocytes of starved[1] or hypophysectomized rats. Results with plasma from bled adrenalectomized rats are included to show that the difference in hæmatocrit is not responsible for the difference seen between unoperated and nephrectomized rats. Similar results were obtained when the erythropoietin titre was measured by the reticulocyte response in mice with transfusion-induced polycythæmia. The need for a control series of animals with the excretory function of the kidney removed, while the possible endocrine function has not been disturbed, is obvious, but at this stage of our work such an experimental preparation has not been achieved. As an approach to such a preparation we have, however, studied rats and rabbits after tying off both ureters.

In order to attain a uræmia at least equal to that which occurs 12 hr. after nephrectomy, we have waited 12 hr. after tying the ureters before giving cobaltous chloride or bleeding the animal, then 12 hr. later (24 hr. after the operation), we collected the blood and assayed the plasma for erythropoietic activity. The plasma erythropoietin level as measured by the uptake of iron-59 (or the reticulocyte response) was only slightly less than that observed in similar assay of anæmic plasma (Table 1).

The blood urea nitrogen of nephrectomized rats reaches a value of 70–90 mgm. per cent by 12 hr. as compared with control values of 21–22. Twenty-four hours after tying off the ureters, the blood urea nitrogen in rats reached values between 125 and 150.

It is possible that the toxic reaction resulting from nephrectomy is sufficiently different from that which results from tying off the ureters to suppress erythropoietin at some site, other than the kidney, in the nephrectomized animals but not in animals that have both ureters tied. Another possibility, not yet tested experimentally, is that erythropoietin is produced as an inactive precursor somewhere other than in the kidney and must be activated by the kidney before its presence can be detected by our assay method. Since, however, the assay is done in an animal with intact kidneys, this possibility seems unlikely. There still remains the alternative explanation that erythropoietin is produced as an inactive precursor by the kidney and is activated by some other tissue. This, however, would not alter our conclusions.

These observations indicate that the rate of erythropoiesis, or, taken as a whole, the dynamic equilibrium of the erythron, is controlled by the amount of circulating erythropoietin, and that its production in the kidney is determined by the oxygen supply–demand relationship of the body. We suggest that the metabolic pattern of the normal animal is determined by many factors, but chiefly perhaps by the endocrine glands. Once the metabolic level is established, the dynamic equilibrium of the erythron is automatic, but it will respond to the various stresses of a normal or abnormal physiological nature that affect the oxygen demand–supply relationship or that interfere with the production or utilization of erythropoietin.

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Benthic Fauna of the Continental Edge off Accra, Ghana

The continental edge off Accra occurs at a depth of about 100 m., about 16 miles offshore. The bottom at this depth consists of outcrops of sandy marine limestone with areas of coarse, calcareous muddy sand with much dead polyzoa, shell and coral material.

This area, between 70 and 100 m., is of interest not only because much of the fauna found has never before been recorded for tropical West Africa but also because this fauna appears to be very exactly related to that found at similar depths in the western Mediterranean in those bottoms which have been termed the '*fonds coralligènes*'. The rock epifauna is dominated by massive colonies of the coral *Dendrophyllia ramea* (L.) to which are fixed large numbers of *Ostrea cochlear* Poli and *Balanus tulipiformis* Darwin. The echinoderm *Astrospartus mediterraneus* (Risso) is common, clinging to a yellow *Gorgonia* sp. to which also large numbers of the lamellibranch *Avicula hirundo* (L.) are attached. The only West African endemic found in quantity is *Antedon hupferi* Hartlaub. This assemblage of fauna is an exact repetition of that reported by Gruvel[1] off Agadir in Morocco at depths of 75–120 m. The Agadir fauna is typically Mediterranean–Atlantic and similar assemblages have been recorded from several points in the western Mediterranean[2]. The fauna of the muddy sand off Accra at similar depths is equally Mediterranean in its affinities. The dominant species is the solitary coral *Caryophyllia clavus* Scacchi, but colonies of *Cladocora patriarcha* Pourtalès are not uncommon. This last species has been recorded from two localities in the Mediterranean but was first described from off the Brazilian coast and is recorded

here for the first time from West Africa. Among the other important species found are the pennatulid *Kophobelemnon stelliferum* (O. F. Müller), the echinoderms *Spatangus purpureus* O. F. Müller and *Anseropoda placenta* (Pennant), and the lamellibranch *Pecten jacobaeus* Lamarck.

It is a long-established fact that the marine fauna of tropical West Africa contains a percentage of Mediterranean species both littoral and sublittoral and the cause of this has been partly attributed to the migrations of the Mediterranean fauna up and down the West African coast in response to climatic changes in the late Pliocene and Quaternary[3]. The situation on the outer edge of the shelf off Accra, however, differs from the general shelf fauna in that almost the entire faunal assemblage is Mediterranean in nature as opposed to a small percentage at other depths. The bottom temperature off Accra at 100 m. is about 15° C., which is comparable with similar depths in the Mediterranean. Further, the bottom temperature at 100 m. varies little down the length of the West African coast between the Mediterranean and the Gulf of Guinea[3,4] (13–16° C., except for a short length of the Moroccan coast which is somewhat warmer). The warm Guinea Current which flows west to east along the Gulf of Guinea is in fact very shallow and with increasing depth the underlying cold water causes bottom temperatures to fall off rapidly at depths more than 50 m.

Unfortunately, there is a complete lack of data for intermediate localities between Morocco and Ghana. Nevertheless, it seems possible that a direct continuity of the marine benthic fauna exists at the present time between the Mediterranean and the Gulf of Guinea, where suitable types of bottom are available in the deeper waters of the continental shelf. This continuity is due, not to tropical submergence but to the peculiar temperature conditions found in the water masses off the West African coast, since the fauna occurs at similar depths in the Mediterranean, Agadir and Ghana.

I wish to thank Miss A. M. Clark, British Museum (Natural History), for her help in identifying the echinoderms.

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Sodium as an Essential Micronutrient Element for *Atriplex vesicaria*, Heward

SODIUM has been recorded as an essential nutrient element only for the blue-green alga *Anabaena cylindrica* Lemm.[1]. It has, however, been shown that increase in dry weight occurs following application of sodium salts to various higher plants growing in low-potassium culture solution and also to members of the Chenopodiaceae growing in solutions containing adequate potassium; views have been expressed that sodium may partially replace the function of potassium or may prevent toxic accumulations of other elements[2]. The object of this communication is to record sodium as an essential micronutrient element for the bladder saltbush (*Atriplex vesicaria*, Heward), to describe the visual deficiency symptoms when plants were grown in solutions carefully freed from sodium and the recovery of such deficient plants on addition of sodium salts.

This species occupies large areas of arid Australia, is an important fodder plant and was chosen for investigation because it accumulates large quantities of sodium chloride in its leaves[3].

Plants of saltbush were grown in a basal culture solution containing the following macronutrient ions (in millimoles per litre): K^+, 6; Ca^{++}, 4; NO_3', 13; NH_4^+, 2; H_2PO_4', 1; HPO_4'', 1; SO_4'', 1; Mg^{++}, 1; and micronutrient elements (in micromoles per litre): iron, 90; boron, 46; manganese, 9·1; zinc, 0·76; copper, 0·31; molybdenum, 0·10; chlorine, 350. Nutrient salts were recrystallized many times, their sodium content being determined each time by flame photometry; salts of the nutrient culture solution contributed less than 0·075 p.p.m. sodium to the nutrient solution. Water, thrice distilled from tinned metal stills, stored in polythene containers, contained 0·0005–0·0008 p.p.m. sodium.

In a preliminary experiment in an ordinary glasshouse, plants growing in the basal culture solution showed significant increases in dry weight when sodium salts (but not when additional potassium salts in equivalent amounts) were supplied at levels of 0·35, 1·75 and 7·0 m.equiv. sodium/litre. When the plants were relatively large and had acquired tertiary branches, the leaves of all plants not receiving sodium appeared paler green than those of plants with added sodium. Analysis of plant organs and culture solutions at the end of the experiment showed an increase of 300 μequiv. sodium above the amount supplied in the culture solution and seeds. This suggested that plants had received sodium, presumably as cyclic salt, from the atmosphere.

To preclude this possibility, a temperature-controlled cabinet was constructed with walls of clear polyvinylchloride sheeting and supplied continuously with filtered air both to culture vessels and to the cabinet itself, which was maintained at a slightly positive pressure to prevent entry of dust.

Bracteoles were removed from seeds, which were then washed in distilled water and germinated on waxed gauze over distilled water; after emergence of the radicle, the distilled water was replaced by basal culture solution of one-fifth full concentration. When 11 days old, the seedlings were transferred to polythene containers, four per container, with 'Perspex' tops and placed in the cabinet. They were continuously aerated through polyvinylchloride tubing dipping into the culture solutions. On the fifteenth day, differential treatments were applied. When harvested on the forty-eighth day, the results shown in Table 1 were obtained.

On the twenty-fifth day, plants which had not received sodium sulphate could be distinguished from those which had by their yellow colour and fewer leaves of smaller area. Necrotic areas, white in

Table 1. EFFECT OF VARIOUS TREATMENTS OF SODIUM OR POTASSIUM SALTS ON DRY-WEIGHT PRODUCTION OF SALTBUSH PLANTS

Treatment		Mean dry weight per vessel
I	No Na_2SO_4	0·056 gm.
II	Na_2SO_4, 0·02 m.equiv./litre	0·340 ,,
III	,, 0·10 ,, ,,	0·513 ,,
IV	,, 0·60 ,, ,,	0·493 ,,
V	K_2SO_4 0·60 ,, ,,	0·066 ,,

Statistical treatment: II, III, IV > I, V at 0·1 per cent level of significance; III > II at 5 per cent level of significance; III and IV indistinguishable; I and V indistinguishable.

Fig. 1

colour, appeared along tips and margins of cotyledons and older leaves on the thirtieth day (Fig. 1) and plants began to die by the thirty-fourth day.

In another experiment, plants were transferred on the fourteenth day after germination to culture vessels containing the basal culture solution, without added sodium. On the sixteenth day sodium sulphate (0·10 m.equiv./litre) was added to one set of culture vessels and seven days later the plants growing in these cultures could be distinguished from the controls by their darker green colour. Symptoms similar to those described above again appeared in cultures which had not received sodium, and by the thirty-first day, when a second set of culture vessels received a treatment of 0·10 m.equiv./litre of sodium sulphate, symptoms were severe. Four days after receiving this delayed sodium treatment, plants showed signs of recovery by a progressive change of colour in older leaves (and in some cases cotyledons) from yellow to green; greening commenced at tips and around the midribs, and gradually spread over the lamina. Plants growing in the set of cultures which received no sodium treatment throughout the experiment became progressively more chlorotic, making little further growth. On the other hand, marked growth occurred in both sets of cultures which received additional sodium. When harvested on the forty-ninth day, the results shown in Table 2 were obtained.

Leaf material from this experiment was analysed for sodium. On a dry-weight basis, leaves of plants from 'no sodium sulphate' cultures contained 350 p.p.m. sodium, whereas leaves from plants which received 0·10 m.equiv./litre sodium sulphate in their culture solutions contained 9,100 p.p.m. sodium.

Table 2. Dry-Weight Changes after Recovery of Sodium-Deficient Plants following Application of Sodium Sulphate Treatment

Treatment	Mean dry weight per vessel
I No Na_2SO_4	0·149 gm.
II 0·10 m.equiv./litre Na_2SO_4 applied on day 31	0·728 ,,
III 0·10 m.equiv./litre Na_2SO_4 applied on day 16	1·656 ,,

Statistical treatment: II > I at 1 per cent level of significance; III > I at 0·1 per cent level of significance; III > II at 5 per cent level of significance.

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[1] Allen, M. B., and Arnon, D. I., *Physiologia Plantarum*, **8**, 653 (1955).
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Bedbugs resistant to Gamma-BHC (Lindane) in Israel

We have received bedbugs, *Cimex lectularius*, which reportedly were not killed by gamma-BHC (lindane), in spite of the fact that the extermination work was carried out by a group of experienced workers. The insects came from a children's home in the Beth Shaan valley in Israel. We have tried to determine the degree of resistance in comparison with animals reared in our laboratory.

The resistance spectrum of our laboratory-reared animals was determined by short-term spraying in a Potter's tower. The bedbugs in groups of ten were placed in half 'Petri' dishes covered with a wire net and passed through the aerosol tower with a velocity of 35 cm./sec. The base of the tower has a length of 50 cm. The amount of the insecticide applied could be regulated by varying the concentration of solution and the number of passages through the tower. (After every passage, an exhaust fitted with a ventilator is opened and the vapours are eliminated from the tower.)

The spectrum of the laboratory bedbugs was taken by two passages through the tower with spray concentrations of 0·05, 0·2 and 0·8 per cent gamma-BHC. The concentrations, under the conditions in our apparatus (amount of liquid sprayed per unit surface), corresponded to 1·5, 6 and 24 mgm. per m.^{2}.

After passage through the aerosols, the insects were transferred to clean Petri dishes. The mortality was determined after 24 hr. The spectrum was determined for young imagines aged about 4–6 weeks. In our laboratory we obtained mortality for groups of ten bedbugs as follows:

0·05 per cent gamma BHC in *iso*propanol	0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 2
0·2 per cent gamma BHC in *iso*propanol	3, 4, 4, 4, 4, 5, 5, 5, 5, 5, 6, 6
0·8 per cent gamma BHC in *iso*propanol	9, 9, 9, 9, 9, 9, 10, 10, 10, 10, 10, 10

The corresponding spectrum for our laboratory strain was:

0·05 per cent gamma-BHC, mortality of 8 per cent (with a deviation of 5·5 per cent)
0·2 per cent gamma-BHC, mortality of 45 per cent (with a deviation of 8·5 per cent)
0·8 per cent gamma-BHC, mortality of 95 per cent (with a deviation of 5·0 per cent)

The bedbugs sent from the children's home could not be killed at all with 0·8 per cent gamma-BHC after two passages. After ten passages (that is, increasing the amount of insecticide five times) we obtained a mortality which corresponds to the lowest insecticide concentration and two passages for our laboratory animals.

This resistant strain was then reared in the laboratory. The bedbugs were fed twice a week on mice or rats respectively, as was done with our normal laboratory strain of bedbugs. After one and a half months the bed bugs, after ten passages of the tower

with 0·8 per cent gamma-BHC, showed a mortality corresponding to the effect of 0·2 per cent gamma-BHC and two passages for our normal strain. We found that continued tests at intervals of six weeks still showed significant resistance against gamma-BHC which varied between 20 and 40 times.

In the meantime, we received a sample of bedbugs from a different part of the country which also showed resistance, although to a lesser degree, namely, 5–10 times.

Bedbugs from Tiberias, which we received as a third consignment, and which have also been tested, showed an increased resistance of 20 times to gamma-BHC. These facts are of interest as we have seen no reference hitherto of resistance of *Cimex lectularius* to gamma-BHC.

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Temperature Preference of *Grylloblatta campodeiformis* Walker

During the field season of 1956, I was able to collect a number of living *Grylloblatta campodeiformis* Walker, some of which I have maintained in the laboratory. The insects are held in individual plastic boxes almost filled with rotten wood and kept in a refrigerator at 4·5° C. After six months, six nymphs remain active and apparently in good condition. They are fed every two or three weeks on *Drosophila* larvæ, and water is added to keep the rotten wood very moist.

These insects have been tested for temperature preference in a circular gradient apparatus to be described elsewhere. Since preliminary tests showed that the insects would not enter air at less than saturation regardless of temperature, all tests were run with saturated air being slowly circulated from the hot to the cool parts of the gradient in such a way that condensation was taking place in all parts of the apparatus.

Each insect was exposed for five minutes and its position recorded at 15-sec. intervals. Five runs with the entire series of insects were made and the mean number of 15-sec. intervals passed at each of a series of temperatures is shown in Table 1. The temperatures given represent the centres of zones in a continuous gradient. Though the gradient extended to both higher and lower temperatures than those given, the insects did not leave the parts of the gradient represented in Table 1.

Table 1. Number of 15-sec. Intervals spent in Various Zones of Temperature in a Circular Temperature Gradient (Temperature in deg. C.)

−3·0	−2·0	−1·0	0·0	1·0	2·0	3·0	4·0	5·0	6·0
1	0	2	18	42	26	15	14	2	0

The preference is centred on 1° C. This finding supports Mills and Pepper's suggestion that *Grylloblatta* do not hibernate[1] but rather move deep into the soil. Certainly, the insects are photo-negative[2], avoid air at less than saturation, and have an exceedingly low temperature preference as well as an ability to move well at temperatures down to − 5·6° C.[3]. This combination of reactions would result in the insects moving into the soil at times of strong surface heating or cooling. I would suggest that this provides an explanation for the frequent failure of summer collecting as well as the success of autumn collecting[1]. An account of collecting experience which supports this interpretation is being published elsewhere.

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[1] Mills, H. B., and Pepper, J. H., *Ann. Ent. Soc. Amer.*, **30**, 269 (1937).
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Population Studies on Three Species of Cladocera

In a biometrical study of three species of Cladocera taken from eight lagoons of the Province of Buenos Aires, in which several measurements were taken of about 940 specimens, some interesting events were recorded. *Bosmina obtusirostris* Sars offers a great variation in measurements with respect to the composition of the population (young and adult individuals taken at random). For the same date, in different years, there can be differences more accentuated than the seasonal ones. For the same date, two different lagoons have similar or distinct populations according to the measurements considered. Different parts of the same biotope have very similar populations if only females with eggs are considered. With respect to the coefficient of variation V, which for the normal cases oscillates between 4 and 10, such high numbers as 21 for the caudal height and length of the mucron have been recorded. Measurements of the antennula are very constant. During the cold months of the year an increment in the height and in the length is noted; but this increment was not recorded in caudal height or the lengths of the mucron and antennula. Therefore, there is no relationship between seasons and proportion of females with eggs. These facts, and some others, point to a singular difference from observations made in European species of the same genus[1].

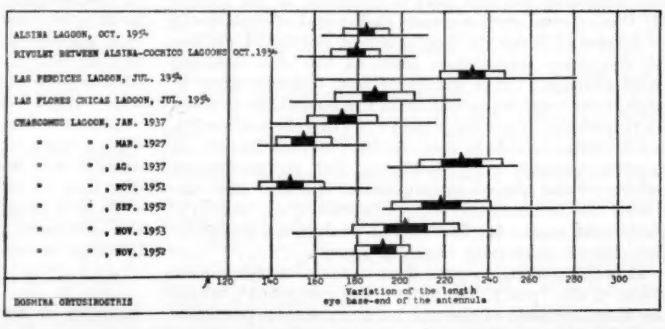
ALSINA LAGOON, OCT. 195-
RIVULET BETWEEN ALSINA-COCHICO LAGOONS OCT.195-
LAS PERDICES LAGOON, JUL. 195-
LAS FLORES CHICAS LAGOON, JUL. 195-
CHASCOMUS LAGOON, JAN. 1937
" " , MAR. 1937
" " , AG. 1937
" " , NOV. 1951
" " , SEP. 1952
" " , NOV. 1953
" " , NOV. 1952
120 140 160 180 200 220 240 260 280 300
Variation of the length
eye base-end of the antennula
BOSMINA OBTUSIROSTRIS

Fig. 1. The horizontal line represents the range of variation, with its corresponding arithmetical mean indicated by the arrow-head. The black rectangle covers twice the standard error to each side of the mean. The whole rectangle, including the white and black parts, represents a standard deviation to each side of the mean (ref. 4)

Contrary to what happens in these Bosminidae, there is considerable uniformity in consecutive samples of *Moina micrura* Kurtz of the same lagoon. It is interesting that this species formed part of the population of the Salada Grande lagoon, according to samples obtained by Olivier[2] until June 1951, when a species new to science, *Moina eugeniae* Olivier[3], replaced it completely. The application of statistical methods to this phenomenon led to the conclusion that there are no intergradations between these species. Further, there have been found resistant eggs or 'winter eggs' in summer months.

A more detailed account of this work will be published elsewhere.

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Nov. 19.

[1] Ramner, W., *Rev. ges. Hydrob. u. Hydrogr.*, **15**, 1/2–3/4 (1926). Vannini, E., *Int. Rev. ges. Hydrob. u. Hydrogr.*, **29**, 5/6 (1933).
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Meiotic Prophase in Female Mice

In a preliminary study of chiasmata in female mice the meiotic prophase was observed in sixty-two females from a variety of strains, mostly outbred. It was found that in all strains the oogonial nuclei in newly born females are without exception in the resting stage probably following the last mitotic division. At about 12 hr. of age the first part of meiotic prophase is appearing and at the age of 60–72 hr. it is completely over. Later the ovary contains oocyte nuclei which are in the 'dictyotene' stage. In this stage they remain until sexual maturity is reached and ovulation starts.

The first part of the meiotic prophase, always visible between 24 and 48 hr. after birth, starts with leptotene and passes through zygotene and pachytene. These stages can be easily seen in squash preparations of the whole ovaries.

The beginning of the dictyotene stage is marked by the appearance of first follicle cells which gather around the oocyte. In most animals the first follicle cells appear at the age of 48 hr. and a few hours later all the oocytes are surrounded by follicle cells.

The accompanying photomicrographs (Fig. 1) show four stages of the first part of prophase in the ovary. (1) Well-spread chromosomes at the end of leptotene; in several of them the beginning of pairing is visible. (2) Zygotene stage when most of the chromosomes show pairing. (3) A group of four chromosomes in pachytene stage separated from the rest of the nucleus by squashing. They are joined to form a chromocentre, a formation which is very similar to that known in spermatogenesis. By following the morphological details of the chromosome pattern the four chromosomes can be identified from Slizynski's[1] or Griffen's[2] pachytene map. (4) The end of pachytene, probably just before chiasmata begin to open.

It is interesting to note that in females there is no trace of the 'puffy' region[1] or the nucleolus[3], which are characteristic of the sex bivalent during prophase in males. Nor is there any chromosomal vesicle from which, according to several authors[3–6], one or both sex chromosomes emerge or grow out during the prophase in males. The absence of these structures from oogenesis suggests that they may perhaps be associated with the *Y*- and not with the *X*-chromosome.

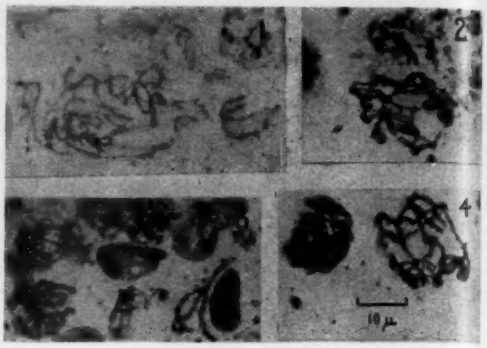

Fig. 1

The timing and the rapid end of the first part of prophase present interesting possibilities from the point of view of studying radiation damage and sensitivity period of the chromosomes in female mice.

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[1] Slizynski, B. M., *J. Genet.*, **49** (1949).
[2] Griffen, A. B., *J. Morph.*, **96** (1955).
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Nature of the Spawning Area of Herrings

Herring spawn has frequently been found in the stomachs of fish. It has also been brought up loose in the trawl on several occasions. Hitherto it has not been taken by other means, and consequently the exact nature of the sea-bed in a spawning area was not known.

During November 1956, while working with R.V. *Sir Lancelot* in the Sandettie–Ruytingen area of the English Channel, herring spawn was found in samples taken with the van Veen grab.

A survey of the area (lat. 51° 06′ 0″ N., long. 01° 40′ 30″ E.) revealed that spawn was generally attached to flints ranging from 1 to 10 in. in length where these occurred over gravel.

The heaviest concentration was found within an area 2 miles long and 350–400 yards wide. The long axis of this narrow strip lay in line with the main direction of tidal movement.

It is significant that herring eggs were found in the stomachs of eight species of fish taken with herrings in the trawl in this area.

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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 25

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. C. Grover: "Geographical Aspects of the British Solomon Islands".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON GRADUATE AND STUDENT SECTION (at Savoy Place, London, W.C.2), at 6.30 p.m.—Sir Gordon Radley, K.C.B., C.B.E.—Presidential Address.

Monday, March 25—Thursday, March 28

PHYSICAL SOCIETY (in the Old and New Halls of the Royal Horticultural Society, Westminster, London, S.W.1)—Annual Exhibition. Discourses:

Monday, March 25

At 6.15 p.m.—Sir Harold Spencer Jones, F.R.S.: "The International Geophysical Year".

Tuesday, March 26

At 6.15 p.m.—Dr. E. Mendoza: "The Supply and Distribution of Liquid Helium".

Wednesday, March 27

At 6.15 p.m.—Prof. E. G. Richardson: "Recent Developments in Acoustics".

Tuesday, March 26

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the MEASUREMENT AND CONTROL SECTION and the RADIO AND TELECOMMUNICATION SECTION, at Savoy Place, London, W.C.2), at 5.30 p.m.—Discussion on "The Performance of D.C. Amplifiers with special reference to the Use of Transistors", opened by Mr. K. Kandiah and Dr. G. B. B. Chaplin.

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS and POLYMER GROUP (at 14 Belgrave Square, London, S.W.1), at 6.30 p.m.—Two papers on "Polymers from Oxacyclobutanes". Mr. A. C. Farthing: "Synthesis and General Properties of Polymers from Substituted Oxacyclobutanes"; Mr. D. J. Sandiford: "The Evaluation of Polymer from 3:3-Bischloromethyl Oxacyclobutane".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Manson House, Portland Place, London, W.1), at 7 p.m.—Mr. S. T. Lunt: "Process Development and Plant Design—The Role of Instrumentation with Particular Reference to the Application of Computers".

Tuesday, March 26—Thursday, March 28

INSTITUTION OF NAVAL ARCHITECTS (in the Weir Hall, 10 Upper Belgrave Street, London, S.W.1), at 10.15 a.m. daily—Spring Meeting.

Wednesday, March 27

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at 14 Belgrave Square, London, S.W.1), at 9.30 a.m.—Symposium on "The Physico-Chemical Properties of Proteins with special reference to Wheat Proteins".

INSTITUTE OF FUEL (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 5.30 p.m.—Four papers on "Dust Deposition and Atmospheric Pollution" by Mr. C. J. Crawshaw and Mr. G. England, Mr. D. H. Lucas, Mr. W. G. Cummings and Mr. W. D. Jarvis and Mr. L. G. Austin.*

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Dr. G. F. Dutton: "Disk Recording".

INSTITUTION OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "Are We Satisfied with the Progress of the Diesel Engine for Future Development?"

OIL AND COLOUR CHEMISTS' ASSOCIATION, LONDON SECTION (joint meeting with the ORGANIC FINISHING GROUP of the INSTITUTE OF METAL FINISHING, at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. E. Knowles and Dr. T. White: "The Protection of Metals with Tannins".

Thursday, March 28

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 10 a.m.—Annual General Meeting.

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Henry Jarvis Hall of the Royal Institute of British Architects, 66 Portland Place, London, W.1), at 4 p.m.—Annual General Meeting and a Symposium on "Sound Recording".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. G. B. B. M. Sutherland, F.R.S., and Mr. M. Tsuboi: "The Infra-Red Spectrum and Molecular Configuration of Sodium Deoxyribonucleate"; Mr. J. F. Davidson and Mr. J. E. Howkins: "Wave Induction on a Vertical Water Film by an Accelerating Airstream".

CHADWICK TRUST (at the Royal Society of Health, 90 Buckingham Palace Road, London, S.W.1), at 5.30 p.m.—Sir Harold Whittingham: "Problems of Hygiene in Civil Aviation"* (Chadwick Public Lecture).

Friday, March 29

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE AND THERAPEUTICS SECTION (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Review of the Ciba Foundation Symposium on "Mechanisms of Development of Drug Resistance in Micro-organisms". Speakers: Prof. J. Lederberg, Prof. M. Westergaard, Prof. B. D. Davis and Dr. R. D. Hotchkiss.

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. H. C. Richardson: "The Re-organization of a Special Library".

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6 p.m.—Dr. E. T. Jagger: "Rotary Shaft Seals—the Sealing Mechanism of Synthetic Rubber Seals Running at Atmospheric Pressure".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "Experimental Demonstrations".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL (with suitable qualifications and experience) OF THE NEWPORT AND MONMOUTHSHIRE COLLEGE OF TECHNOLOGY—The Joint Clerks to the Governors, Education Department Civic Centre, Newport, Mon (March 30).

LECTURER (with a good university degree or equivalent technical qualifications, and experienced in the teaching of technical subjects) IN TECHNICAL EDUCATION—The Registrar, The University, Manchester (April 1).

LECTURER OR ASSISTANT LECTURER IN PURE MATHEMATICS: ASSISTANT LECTURER IN INORGANIC OR PHYSICAL CHEMISTRY; and an ASSISTANT LECTURER IN PHYSIOLOGY—The Secretary, Queen Elizabeth College (University of London), Campden Hill Road, London, W.8 (April 5).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (April 6).

LECTURER OR ASSISTANT LECTURER IN PHYSICS at the American University, Beirut—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting N.1 (April 6).

LECTURER IN PURE MATHEMATICS at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 8).

RESEARCH FELLOW IN ENTOMOLOGY at the Waite Agricultural Research Institute, University of Adelaide, Australia, to take part in a research programme now in progress upon insects affecting lucerne, including problems of seed production and pollination—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Australia, April 8).

LECTURER IN THE DEPARTMENT OF BACTERIOLOGY—The Secretary, The University, Edinburgh (April 10).

ASSISTANT LECTURER IN GEOLOGY; and an ASSISTANT LECTURER IN SOCIOLOGY—The Registrar, University College, Leicester (April 13).

LECTURER IN PHYSICS; a LECTURER IN CHEMISTRY; and a LECTURER IN MATHEMATICS at Kumasi College of Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (April 15).

PLANT PATHOLOGIST (preferably with a doctorate degree), to carry out plant pathological research concerned with fungal, bacterial and virus diseases of tobacco, together with the development of control measures—The Director, Tobacco Research Board of Rhodesia and Nyasaland, P.O. Box 1909, Salisbury, Southern Rhodesia (April 15).

PHYSICISTS (with an honours degree or equivalent) AT THE RESEARCH LABORATORIES, Leatherhead, Surrey, to undertake work on the non-destructive testing of materials for conventional and nuclear power stations—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. T/121 (April 23).

UNIVERSITY LECTURER (with an honours degree in mathematics and experience of research and teaching in statistical methods including the application of statistics to experimental work in agriculture) IN STATISTICS—The Secretary, School of Agriculture, The University, Downing Street, Cambridge (April 23).

ASSISTANT DIRECTORS (2) OF RESEARCH, and a SENIOR DIRECTOR IN RESEARCH IN THE SCOTT POLAR RESEARCH INSTITUTE—The Secretary of the Appointments Committee, Department of Geography, The University, Downing Place, Cambridge (April 30).

ASSISTANT LECTURER OR LECTURER (preferably interested in applied geology) IN GEOLOGY—The Registrar, The University, Leeds 2 (April 30).

DIRECTOR OF THE SCOTT POLAR RESEARCH INSTITUTE—The Secretary of the Appointments Committee, Department of Geography, The University, Downing Place, Cambridge (April 30).

HEAD OF THE DEPARTMENT OF GENETICS (Principal Scientific Officer or Senior Principal Scientific Officer grade)—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford, Herts (April 30).

IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWS IN CHEMISTRY, PHYSICS and allied subjects, for example, PHARMACOLOGY, ENGINEERING, METALLURGY—The Registrar, The University, Manchester 13 (April 30).

LECTURER IN PHILOSOPHY (Grade II)—The Registrar, The University, Bristol 8 (April 30).

SENIOR LECTURER IN SOIL SCIENCE; and a LECTURER IN AGRICULTURAL CHEMISTRY at Kumasi College of Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (April 30).

TURNER AND NEWALL RESEARCH FELLOWS IN ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or an allied subject—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 30).

ASSISTANTS (2) IN PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (May 1).

GEOLOGISTS (graduate geologists or mining geologists with a minimum of five years field experience), for service in southern and eastern Africa; based on overseas offices of the Authority—The Establishments Officer, United Kingdom Atomic Energy Authority, 14 Ormond Yard, London, S.W.1.

LECTURERS (2) (with an honours degree in chemistry and considerable research experience) IN CHEMISTRY; and ASSISTANT LECTURERS (5) (with an honours degree in chemistry and some research experience) IN CHEMISTRY—The Registrar, The Manchester College of Science and Technology, Manchester 1 (May 1).

LABORATORY TECHNICIAN (PHYSICS)—The Registrar (PT), Queen Mary College (University of London), Mile End Road, London, E.1.

LECTURER IN THE DEPARTMENT OF PHYSICS—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

LECTURER (woman, with sound academic qualifications and teaching experience) IN CHEMISTRY—The Warden, Goldsmiths' College, New Cross, London, S.E.14.

MATHEMATICIANS (preferably with a degree, or at least H.S.C. with mathematics as a principal subject, or G.C.E. in five subjects, including mathematics and one other subject to advanced level), to assist Mathematical Physicists in the study of basic physical phenomena occurring in atomic explosions—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting Ref. 1436/34.

METALLURGISTS or PHYSICISTS for research on (*a*) properties of liquid alloys as related to behaviour in nuclear reactors, and (b) physical metallurgy of the newer metals—Prof. J. G. Ball, Metallurgy Department, Imperial College, London, S.W.7.

PHYSICIST or ELECTRICAL ENGINEER (with a first- or second-class honours degree in physics or electrical engineering, and capable of applying radiation theory) IN THE METALLURGICAL DEPARTMENT, R.A.E., Farnborough, Hants, for work on aerials generally, and possibly on related field of radio wave propagation—The Ministry of Labour and National Service, Technical and Scientific Register (K). 26 King Street, London, S.W.1, quoting A.82/7A.

PHYSICIST or MATHEMATICIAN (with a first- or second-class honours degree in physics or mathematics or equivalent, and some knowledge of aircraft stability and either modern electrical instruments or statistics) AT THE ROYAL AIRCRAFT ESTABLISHMENT, Bedford, to carry out full-scale flight investigations—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.78/7A.

PHYSICS LABORATORY TECHNICIAN (with ability in instrument construction and some knowledge of electronics, and preferably a qualification in physics, technology or engineering)—The House Governor, Charing Cross Hospital, London, W.C.2.

SENIOR LECTURER IN ELECTRICAL ENGINEERING at the University of Rangoon, Burma—The Ministry of Labour and National Service (E9), Almack House, King Street, London, S.W.1, quoting A.12/BUR/TCS/88.

STATISTICIAN (with a good honours degree in mathematics or statistics, and preferably an interest in agriculture or biology)—The Secretary, Grassland Research Institute, Hurley, Maidenhead, Berks.

TECHNICIAN (preferably with an interest in biochemistry) IN THE CLINICAL PATHOLOGICAL LABORATORY—The Secretary, The National Hospitals for Nervous Diseases, Queen Square, London, W.C.1.

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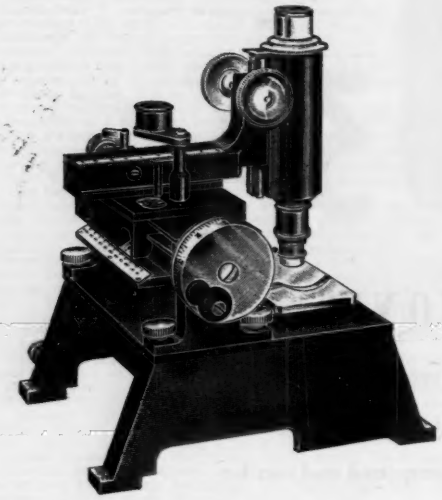

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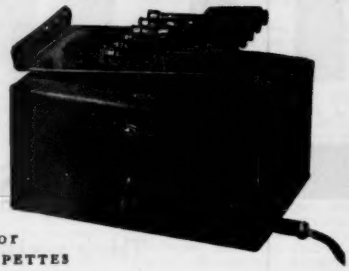

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